ENGINEERING NEWS

THE report of Lieut. C. C. ROGERS, U. S. N., a summary of which by himself appeared in the *N. Y. Herald* last week, paints the future of the Panama canal enterprise in anything but bright colors. He says that the French engineers now estimate the total cube of excavation at 105,000,000 cu. metres; sometime ago they put this figure at 120,000,000 cu. metres and careful observers say that 150,000,000 would be nearer the probable quantity. The total quantity removed to January, 1887, according to the engineer's official returns, was 30,144,318 cu. metres, of which 11,727,000 cu. metres were excavated in 1886. These figures do not appear to take into accounts the quantities that have been washed back by the floods into the ditch that would cancel a considerable percentage of the "work done." The formidable Culebra cut and the damming of the Chagres river are yet practically unsolved problems. And Lieut. ROGERS now points out the fact that the mountain on the left side of the Culebra cut is found to be moving bodily towards the axis of the canal at an annual rate of from 12 to 18 in. owing to the cutting away of its bottom support. This is a very serious matter, and the danger would naturally increase as the cut deepens until this one thing alone may render the whole scheme a failure. From a private source we also have the further information that the Culebra mountain is not the only thing that moves along the line of the canal. While the mountain is sliding sideways, the bottom of the canal on the lower portions of the route are reported as being forced upwards, by the mass of excavated material piled on the sides of the cut, to such an extent that in certain localities it requires a very healthy and hardworking dredge to hold its own. In fact our informant directly tells us that one of the American excavators has been hard at work in keeping itself simply afloat in practically one spot for some months. The engineer in charge of this particular dredge philosophically remarked that he was well paid and stood the climate reasonably well, and as his employers were paid by the cubic metre excavated he had no particular concern in the expected advance.

With all these natural difficulties to combat, coupled with a climate that few can long withstand, the financial managers in Paris are having troubles no less formidable. Lieut. ROGERS estimates that were "all the necessary money at hand and men and machines worked to their utmost, it would require seven years to finish the Canal." Out of the $275,000,000 of acknowledged obligations of the Company less than $183,000,000 has been realized for actual work on the Canal, and on March 1, 1887 the total sum available was $45,686,461. The annual expenditure for interest, service of the debt and adminstration at Paris and Panama is now $16,000,000. Lieut. ROGERS estimates that the total cost of the canal will be not less than $375,000,000, or $192,000,000 more than the amount actually available for Canal work. As the last loan was marketed at 45 cts. on the dollar, or a little more than $41,000,000 realized from obligations amounting to $91,760,400, terms equally favorable—not likely to be the case—would raise the final obligations of the Canal company to $700,000,000. This report of Lieut. ROGERS is almost as discouraging to investors in the Canal securities as that lately made by civil engineer BOYD, of London, who put the ultimate cost at $440,000,000 and the minimum time of completion at 12 years.

In connection with the difficulties at the Culebra cut, Capt. W. L. MERRY, who claims to be well acquainted with the topography of the Isthmus, speaks of the troublesome subterranean waters of that locality. He says a well on the summit of the Culebra division of the Panama R. R. supplies the engines the year around. And that as the whole region is volcanic in character, the soil is full of cavities and fissures which are filled with water by a rainfall averaging 120 in. per annum. The striking of these underground streams in the cuttings accounts for the formidable slides of material which are now giving so much trouble.

LAST week the Rapid Transit Commission of New York adopted certain plans for the West and South street annexes to the New York elevated railway systems. These plans were practically the same as those submitted by the Manhattan Co., with some modifications by the commission. In general character the branches will be like the Sixth avenue line. The average height of the track from the street will be 23 ft. The stations will be in the middle, half way above and halfway below the track, and will be 14 ft. from the street. The structure will be connected with all the ferries by bridges 14 ft. above the street. From South Ferry to Coenties-slip four tracks will be allowed. There will be four tracks in Battery Park. They will come in on a level grade with those already there. The loop will occupy a section of the park about 260 by 50 ft. The estimated cost of the structure per mile is $600,000, and for rolling stock and equipments $150,000 per mile additional. There are three and three hundredths miles in the new routes. The Commission inserted a clause in the agreement whereby the bridges connecting with the ferries would be under the control of proper municipal authorities, and also added to the plans a track-walk of perforated iron, 3 ft. wide, and provided with hand railing.

THE most serious railroad accident of the week was a collision at Shelby, O., on June 6. The collision occurred between two freight trains at the crossing of the Baltimore & Ohio Railroad and the Cleveland, Columbus, Cincinnati & Indianapolis Railroad. One man was killed. The loss is estimated at $75,000.

DURING the week floods have occurred in the far west. In Montana a wagon road was washed out, a highway bridge wrecked, and the abutments of a bridge on the Utah & Northern Railroad undermined. Several bridges over the Bow river, Northwest Territory, on the Canadian Pacific Railway, have been carried away.

THE extraordinary feat of rapid railroad building which the St. Paul, Minneapolis & Manitoba is performing in Northern Dakota and Montana is without precedent in the annals of railroad work. Messrs. SHEPARD, WINSTON & Co. are to complete 558 miles of the railway from Minot, Dak., to Great Falls, Montana, in the five months ending Sept. 1, through a country uninhabited and without transportation facilities. In order to save transportation charges, the line is extended from the eastern end only, and all supplies are brought over the line from the depot at Minot, where they were accumulated during the winter, except for the part of the road along the Missouri where some of the contractors have chartered steamers to bring in their supplies. The total amount of earth to be handled on the line is not far from 10,000,000 yards and 6,500 men and 3,500 teams are now employed on the grading forces. To direct the labors of this vast army, furnish them with food, tools and supplies, see that the tracklaying and bridge building forces suffer no delay from lack of material or from delayed work of the graders, necessitates an amount of generalship and executive ability in no wise inwise inferior to that required in great military operations. To Superintendent EGAN of the Manitoba, belongs the important function of moving the construction material and supplies to the end of the track. The magnitude of his work will be indicated by the fact that this year he has forwarded over 10,000 car loads to Minot, and that, after having drawn upon Minot for the material necessary to construct 120 miles of railroad, there remained in store at that point 32,294 tons, or 321 miles of steel rails, and 433,000 ties equal to 114 miles, with corresponding quantities of other material and commissary supplies. The loaded cars are kept constantly moving to the front and the whole system is managed with such regularity and precision that the contractor's needs are always anticipated.

The work of keeping the completed grade so far ahead of the tracklayers as never to be in their way, is under the immediate superintendence of PETER SIEMS, a member of the contracting firm. The work is parceled out among sub-contractors, whose camps are strung along for 160 miles beyond the end of track. The supply trains are kept near the end of the track, and from them long caravans of freighters' teams are constantly moving to the graders' camps or the lesser depots which supply them. An interesting feature of the train is the hospital cars, where the laborers suffering from disease or accident are cared for by a physician and nurses, the expenses being met by a contribution of two cents a day from each laborer employed.

A HIGHWAY bridge at Butler, Mo., fell on Monday last under a traction engine, killing one man and nearly killing another. It had probably not been considered necessary to take into consideration rolling loads of that nature. We infer that it was only a common (too common) kind of modern bridge.

THE preliminary car-coupler tests last week, on June 7 and 8 were conducted with very remarkable ability and success,—they appear to have satisfied the competitors. We postpone more definite report until there is something more definite to report, but the outlook seems hopeful that the latter will be of a satisfactory nature. There is nothing except the difficulty of a choice to explain or excuse further delay. No coupler is probably perfect, but there are quite a number which are as nearly so as any device can well be made in advance of wide and general use and which if already in use, no one would think of abandoning.

In the mean time the Master Car Builders' committee has taken the very important action noted elsewhere, which may render the labors of this committee superfluous, except as it may have inspired this action.

IT is reported that the contract for a part of the work of draining the valley of Mexico, has been awarded by the Mexican Government to the Bucyrus Construction Co., of Cleveland, O. The contract involves the immediate expenditure of $1,000,000, with much more in prospect and it is stipulated that the work shall be done by native labor; but American superintendents may be employed. A canal will be constructed around the city of Mexico, connecting the lakes and draining the valley, as part of a vast drainage system to be undertaken by the Government at a total estimated cost of between $5,000,000 and $6,000,000. The tunnel through the mountains, which was commenced during the reign of MAXIMILIAN, will be constructed by the Government. The construction company is headed by W. H. HARRIS, H. C. ROUSE, and D. P. EELS, of Cleveland. Work will be commenced in August and will continue for about three years.

THE bridging of the Hudson at Poughkeepsie is causing no little activity among railway projectors and many schemes and surveys have been and are in progress for connecting lines at either end. But the Pennsylvania & New England Construction Co., who are building the bridge, are pushing the largest project and seem to be in a fair way to carry it through. They purchased some time ago the Pennsylvania, Slatington, & New England Railroad, partially built between Slatington, Pa., and Pine Island, N. Y., and engineers are now locating the line southwest from Poughkeepsie preparatory to early construction. They have also obtained a controlling interest in the Hartford & Connecticut Western Railroad and have located a line from Poughkeepsie east to Jackson's Corners to connect with it. From Hartford it is proposed to build or obtain a line to Springfield and a connection with the Central Massachusetts line to Boston. With the final settlement of the legislative action which has excited so much controversy, it is expected that work will be actively pushed and the whole line be finished ready for operation by the time the bridge is completed.

A concession is reported for the construction of the first Persian railway. The syndicate is made up of Belgians and the line is to run from Teheran to Shah-Abdul-Azim a distance of about 6 miles. Th latter place is a celebrated point of pilgrimage. The same concession entitles the Belgians to the exclusive right of constructing a line from tne Caspian Sea to the Persian Gulf. The company is the *Societé Anonyme Belge des Chemins de Fer Persans* of Brussels.

IN our notice, last week, of City Engineer ARTINGSTALL'S report on the proposed increased water-supply for Chicago an undetected typographical error made us say feet instead of *fathoms* in speaking of the depth of the water at four miles from shore. The sentence referred to should read "from 6 to 9 fathoms deep."

Tunnel-Driving through Loose Material, by the Bourdiol System.

In tunnel-driving, whether the system followed be Belgian or French, English or Austrian, the first thing excavated is an advance heading. The driving and timbering of this heading presents no great difficulty when the ground is firm, and it becomes simply a question of time, dependent upon the perfection of the mechanical means employed.

But when, on the contrary, the ground to be pierced is of a soft and unreliable nature, it becomes necessary to use some method of supporting the sides and roof and the working face as well. The ordinary systems of timbering in such cases are too well known by tunnel-men to need extended description here. But we can say that much timber and time is consumed, it is hard and dangerous work for the timber-men and it is expensive. To obviate these difficulties and also to reduce the expense, M. BOURDIOL, sub-chief of section, *Ponts et Chaussees*, has invented the "perforator" which is to be described and illustrated.

This machine is made up of two metallic caissons, A and A' (Figs. 1, 2, 3), fastened together but having a forward motion independently of each other. These caissons each have a shield B, a cutter C, a rear shield or mask M, screws V and V', etc. These caissons are regular iron boxes in which only the two ends parallel with the face of the heading are open, and these sides can be closed as will be shown later. The upper and lower caissons are identical in all points and are each 2.46 ft. high, 3.28 ft. wide and 2.624 ft. deep; they are each provided with a pair of advancing screws, as shown. These screws are worked by the ratchet-levers L, L', etc., abutting against the metallic frame work Q placed in their rear. The front ends of the screws are united by an axle m, m', upon which is mounted the mask M, which latter is made of four wings or flaps with hinges revolving around m, m', (see Fig. 4).

Parallel to the heading-face are three axles b, b^1, b^2, (Fig. 2), the first two at the top and bottom of the front of the caisson and the third at the top of the rear end of the caisson. These axles have at their extremities ratchet-wheels r^2 (Figs. 2 & 8), over which pass the studded chains G. Over a certain length these two chains are joined together by a series of iron plates jointed together, and extending over the full width of the caisson; the first plate has a blade upon its lower edge, and forms the cutter C (Figs. 7 & 8), and together these plates form the shield B.

The rear-axle r^2 has at its center a ratchet-lever l, which is used to manipulate the chains G. The sides of the caisson are closed by plates of iron sliding into the openings R (Fig. 6) each plate being about 8 in. wide.

To operate the Bourdiol "perforator" supposing it to be in position as shown, the first thing to do is to open the flaps in the front of the mask M and keep them in this position by the buckle T. Then the caisson is made to advance some distance by the screws V worked by the levers L; when this forward movement has reached its limit, the manipulation of the chains G by the upper lever l causes the cutter C to penetrate into the soft earth, and the shield B is hauled down after it, thus closing the front of the caisson, and isolating a cube of the material equal to the advance made by the caisson. The mask M is then thrown up, and the material withdrawn from the caisson. To repeat the operation the shield is first withdrawn to the top of the caisson and the mask readjusted. But it is absolutely necessary that the two caissons be operated alternatively. It is apparent that as the work is successively executed in a species of lock, isolated from the tunnel proper, there can be no danger from the running of loose sand, etc. This method conforms in all its points to the ordinary process, only the work is done mechanically and methodically.

According to the statement of its inventor this machine has made an advance of from 7 to 10 ft. in 24 working hours. The supporting framework back of the caissons is made of iron and strongly put together with members that can be handled readily by two men.

With the advance heading driven, the tunnel is enlarged for the masonry in sections 10 ft. in length. To do this two timbers K are set across the roof and supported by the posts P (Fig. 1), and on these timbers in the line of the tunnel rests the sheeting plank, about 5 ft. long. A third timber is put in holding up the ends of the sheeting already driven, which last post is braced. This timbering is extended to a point slightly above the spring of the arch, when the centers can be put in place and the masonry commenced.

For the purpose of reducing the amount of timber and utilizing to the best advantage the room at his disposal, M. BOURDIOL has devised a center (Figs. 9 and 10) that the miners can put up as the material is removed. This center, which practically replaces the temporary timbering as it is removed, is made up of three ribs, each including seven segments an

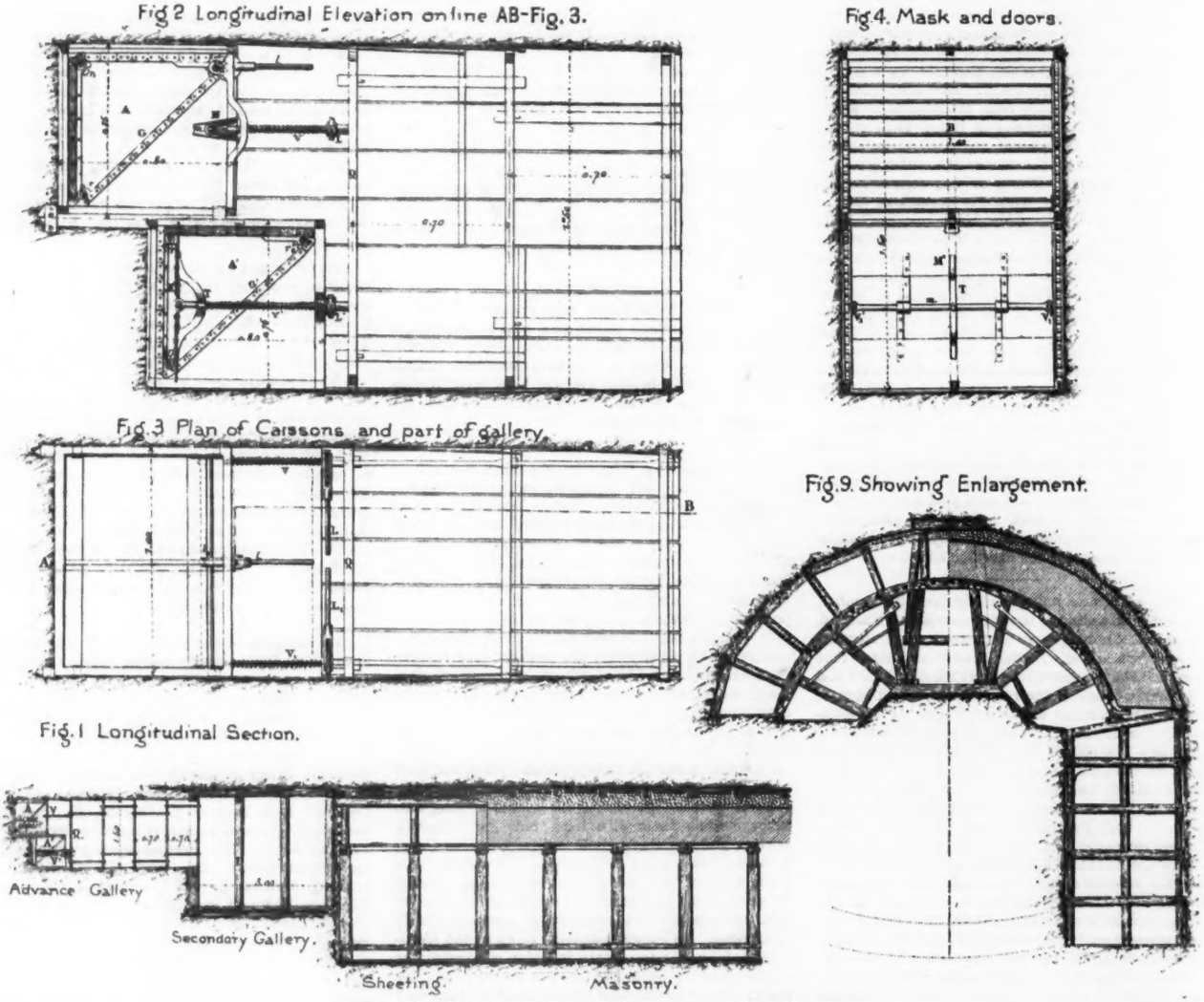
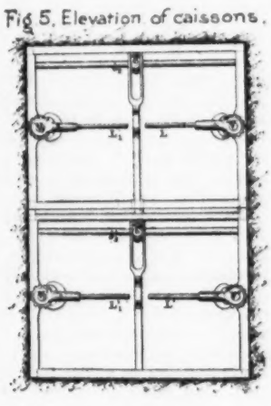
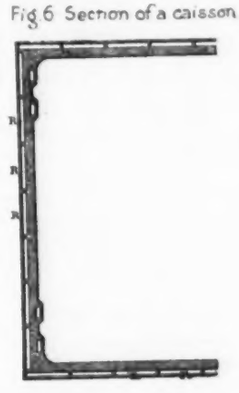


Fig. 2 Longitudinal Elevation on line AB-Fig. 3.
Fig. 4. Mask and doors.
Fig. 3 Plan of Caissons and part of Gallery.
Fig. 9. Showing Enlargement.
Fig. 1 Longitudinal Section.
Advance Gallery
Secondary Gallery.
Sheeting.
Masonry.

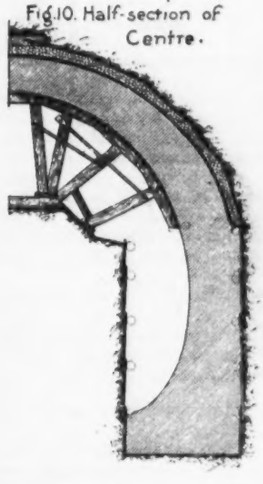
Tunnel-Driving through Loose Material by the Bourdiol System.

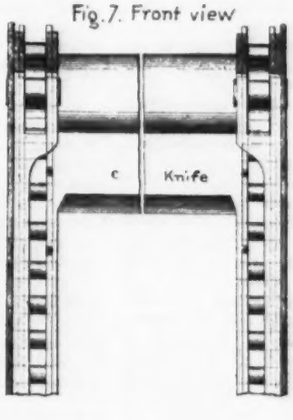
eight braces. The enlargement is really commenced on this center, by supporting the ends of the timbers *K* on short posts resting on the center when the posts *P* are removed, This system is carried out from the crown of the arch to the springing lines. The rios are tied together longitudinally, or on the tunnel axis, by iron beams which are provided on their upper edges with ledges for supporting the centering (See Fig. 9). To use this center successfully, as it rests upon the material left in the axis of the tunnel, care must be taken not to disturb this material in sinking for the sidewalls of the tunnel.





DETAIL OF CHAIN





Tunnel-Driving by the Bourdiol System.

G. L. PESCE in *Le Genie Civil*, May 14, 1887.

EFFICIENCY OF CABLE ROADS.*

Its Variation with Length of Cable and Other Elements of the Construction.

BY JAMES A. SEDDON. MEM OF ENG.'S CLUB OF ST. LOUIS.
(Read Feb. 2, 1887).

I suppose almost every engineer has heard more or less loose talk about cable roads, both by their advocates and their opponents. The balancing of up and down grades, and easy increase in service, on the one hand, and the loss of power in pulling a heavy cable for nothing, on the other, and so on *ad infinitum*. But, unfortunately, the saving or the loss in any case has rarely been reduced to actual figures.

Having had my attention called to some questions of the efficiency of this method of transportation, I could find very little that had been published on the subject, and some of that little misleading. I have therefore gathered together what facts I could, and have used them in connection with a fairly full theoretical discussion, in the hope of either inducing the publication of further facts, or stimulating the collection of further data, which would be very useful to the engineer in planning and the superintendent in operating this class of roads.

*From Journal of the Association of Engineering Societies.

As in the case of the beam, it is apparent that there is a limit to the length of cable, beyond which it could not be made to draw its own weight, and that as it increased in length the efficiency, or "power expended in drawing cars," divided by "total power expended," must decrease. The purpose of this paper is a consideration of this decrease in efficiency, together with the differences in efficiency for different factors of safety with which the cable is worked, and the differences in efficiency for different values of constant dependent on the construction of the road (size of sheaves, etc).

The first, change of efficiency with length of line, is an important factor in the location of power stations, for it is simply an equation between cost of wasted power and cost of power stations whether a line should be operated from one or from two stations, or, in case of one station, what extra expense should be incurred in cost of site to place the power station about the middle of the line and operate it with two cables.

The second, differences in efficiency for different factors of safety, is one step in the determination of what would be exactly the most economical size of cable to use for any given road. The second step would be the life of cables with different factors of safety. This second step will probably only be determined slowly by practice.

In the third, differences in efficiency for differences in constants of construction, the writer regrets that he can only show what differences in efficiency may be thus caused; he at first hoped to be able to connect this change in the constant with the specific differences in construction, such as size of sheaves, number of curves, depression pulleys where there were any, etc. The scattering data which he could collect, however, was insufficient for this. But he hopes that the large effect that differences actually found in this constant have no efficiency may call attention more especially to this subject, so that this change may be soon quantitatively connected with its specific causes.

In this discussion, the pull on the cable required to operate the road will be used as offering a simpler method than by horse-power (H. P.). This pull taken in pounds and called P is the difference in tension of the cable on the taut and slack side of the driving drum. P is related to the H. P. required to operate the road by the equation $\frac{P\ v}{550} = \text{H. P.}$ where v is the cable velocity in feet per second. In the above, as also through this paper, the small fraction of the power used in running the machinery up to the driving drum is neglected.

This total pull is divided into the pull required to run the cars on the line, and the pull required to run the cable. It may be written:

$P = P_1 + P_2$ { P_1 = total pull in pounds of the cars. P_2 = " " " " cable.

Considering first P_1, it is apparent that, with a given average pull for each car, and with the cars at a given distance apart, comparing one length of line with another, there would be twice as many cars, or twice as much total car pull on a line twice as long, three times as much on a line three times as long, etc. Or $P_1 = K_1 L$, where L is the length of a given cable road in feet, single line, and K_1 is a constant to be determined for each road, from the average resistance to traction per ton of car load, multiplied by the average weight in tons of a loaded car, multiplied by the number of cars on a unit length of road. As used in the final calculations, L will be taken in units of 1,000 ft., so that in this form the equation becomes

$$P_1 = 1{,}000\ K_1\ L \qquad (I.)$$

The resistance to traction per ton has been made the subject of very careful experimental determinations on steam railroads, but street roads with flat rail heads and different journals present enough variation to make the use of these experiments quite uncertain.

About the only applicable data that I have been able to find on this subject is from a paper by Mr. A. W. WRIGHT in the *Journal of the Association of Engineering Societies*, December, 1885. In this, from a number of dynamometer measurement, he finds on new steel rails an average resistance per ton for street cars of 15.6 lbs. This is the pull required to keep in motion at about 7 miles per hour, and does not include the extra pull required to start cars. He also gives some experiments of D. J. MILLER, M. E., while employed on the Chicago cable road, from which he deduces the pull per ton as 10.95 at about the same velocity, including power to start. He, however, states that in this case the weight of passengers was estimated without a count of their number, and concludes that an overestimate of passengers accounts for this small value of resistance to traction. It does not seem impossible, however, that resistance to traction may be somewhat less for cable roads than what is generally found on horse roads, as the rail on the cable road is generally cleaner.

The resistance to traction per ton on cable roads is a value that could so easily be determined on any cable line by connecting the coach to the grip car through a dynamometer and dividing mean pull by weight in tons hauled that any attempts to more exactly *estimate* it would be unnecessary. When once well determined it might be considered a constant, as the variation in speed of different roads would probably not be enough to materially effect it. This resistance to traction in pounds per ton hauled being called f_c and neglecting the extra resistance of curves, which would have a special value for each road, the value of K_1 in terms of those elements that must be adjusted to suit the travel will be almost exactly expressed by the following formula:

$$K_1 = \frac{w}{60\ v\ t}\left(f_c + \frac{2{,}000\ v^2}{d \times 2\ g}\right)$$

Where w is the average weight of a loaded train in tons.
v " cable velocity in feet per second.
d " average distance between stops in feet.
t " mean actual time in minutes between trains.
g " acceleration of gravity = 32.2.

The above formula requires no further explana-

tion, it being simply an expression for the mean car pull per foot of cable line, the work used in starting cars being distributed over the line, and the number of cars pulling being taken at $\frac{v_1}{v} \times$ (No. of cars on line), v_1 being the mean velocity of the cars. It has been called almost exact; this is because the time that a car was loose on the cable at a stop has been taken as equal to the time lost at that stop. This would be the case exactly if the time used in stopping the car were the same as that used in starting it again. A slight difference that might exist in these times would cause the formula to be in error an inappreciable amount. Also f would not be theoretically constant through the variable velocity of the start. Altogether the possible errors in the formula on any actual road would hardly affect the value of K_1 in the fifth decimal place, or beyond the range to which calculations would be carried.

A tabulation is here presented giving the values of K_1 for those different values of the elements on which it depends. It represents about the range that might be found necessary in the different services for which this class of roads would be built.

In the following table d, or the mean distance between stops, has been taken as 1,000 ft. This quantity without very careful statistics for each road can only be an estimate, but as it only enters once to the first power in the smallest term for K_1, moderate changes in it would only slightly affect the above values. In the paper by Mr. WRIGHT, above referred to, he states from his experience on one of the Chicago roads, the average distance between stops was in that case 1,178 ft. f_c has also been taken in this tabulation as 10; this gives for a 7 miles velocity a resistance to traction per ton, including starting, of 13.3 lbs. This value is between that of Mr. MILLER'S of 10.95, and Mr. WRIGHT'S of 15.6; the first on cable lines, including starts, the second on horse lines, excluding starts; but as before stated, no very close calculation can be made on this subject until more data are collected on car friction. However, the object of the above tabulation is to show how the value of K_1 will vary with the more important variables, velocity of cable, average weight of trains and time between trains, and about the actual variation of K_1 that would be found on different roads running trains is covered in this tabulation, though further investigation in car friction might show that these values of K_1 here given were not assigned to exactly the right cable velocity or average weight or time between trains.

In what follows K_1 will enter the general formula as a quantity to which a value must be assigned in each case, which value is determined, as shown above, by the special demands of the service in that case. But in the special investigation of the variations of efficiency with different length of road, etc., a value of 0.0812 will be taken for K_1, or the tabular value of a 3-minute service, 8-mile velocity of cable and 12 tons average weight of trains. This is some, what smaller than the correct value for the St. Louis Cable Road.

TABULATION.
VALUES OF K_1.

v in miles per hour.	X.	$w = 8$.				
		$t = 2$	$t = 3$	$t = 4$	$t = 5$	$t = 6$
6	0·0235	0·0940	0·0627	0·0470	0·0376	0·0313
7	·0216	·0864	·0576	·0432	·0346	·0288
8	·0203	·0812	·0541	·0406	·0325	·0217
9	·0194	·0776	·0517	·0388	·0310	·0259
10	·0190	·0760	·0507	·0380	·0304	·0253
		$w = 10$.				
6	0·0235	0·1175	0·0783	0·0587	0·0490	0·0392
7	·0216	·1080	·0720	·0540	·0432	·0360
8	·0·03	·1015	·0677	·0507	·0406	·0338
9	·0194	·0970	·0647	·0485	·0388	·0323
10	·0190	·0950	·0633	·0475	·0380	·0317
		$w = 12$.				
6	0·0235	0·1410	0·0940	0·0705	0·0564	0·0470
7	·0216	·1296	·0864	·0648	·0518	·0432
8	·0203	·1218	·0812	·0609	·0487	·0406
9	·0194	·1159	·0773	·0579	·0464	·0386
10	·0190	·1140	·0760	·0570	·0456	·0380
		$w = 14$.				
6	0·0235	0·1645	0·1097	0·0822	0·0658	0·0548
7	·0216	·1512	·1008	·0756	·0605	·0504
8	·0203	·1421	·0947	·0711	·0568	·0474
9	·0194	·1358	·0905	·0679	·0543	·0453
10	·0190	·1330	·0887	·0665	·0532	·0443

$$K_1 = \frac{w}{60\,v\,l}\left(f^c + \frac{2{,}000\,v^2}{d \times 2\,g}\right) = \frac{w}{l}.X$$

w = Average weight of trains in tons.
v = Cable velocity in feet per second.
d = Average distance between stops = 1,000 ft.
l = Mean actual time in minutes between trains.
$2\,g = 64.4$.

f^c taken as 10.

It may be here stated that, of course, about the maximum service must be taken in determining the value of K_1, since size of cable should be designed for this service; and further, that it is only the efficiency for this maximum service that is the subject of consideration in this paper. It is plain that if the size of cable is fixed by this service, and hence power to pull cable is fixed, the greatest efficiency for a given allowable strain in the cable will be obtained at this maximum service, and that from this value the actually realized efficiency may decrease to zero as the cars are more and more nearly all taken off the road. The relation of the actually realized efficiency to this maximum efficiency may be easily determined in any given case, knowing the fluctutions of the service, but a consideration of this is beyond the purpose of this paper.

Having considered briefly the nature of this constant in the equation for the more simple variation of total car pull with length, it will be necessary to consider in greater detail the variation of total cable pull, or P_2 with length. It may be said that P_2 should vary directly with total weight of cable, or $P_2 = K_2$ (cable weight), but to see exactly under what condition this equation exists, it will be necessary to review some of the principles underlying this method of the transmission of power. If in this I am repeating what is familiar to many of you, it is simply to avoid the possibility of being misunderstood by some, and I hope on that account I may be pardoned in explaining, perhaps with unnecessary care, precisely the steps taken.

P_2, which is the force that overcomes the friction resistance to the movement of cable, may be taken as meeting a resistance made up of two elements. First, an element of friction due to the weight of the cable. Second, an element of friction due to the tension of the cable. The first is simply a weight pressure on a number of journals, and for sheaves and journals of a given size may be taken as $f_r \times$ (cable weight), where f_r is the co-efficient of friction for a given pulley and cable weight is the total weight on all the pulleys. Second. The element of friction due to tension would occur mainly at curves, depression pulleys, etc., or wherever a bend in the cable caused the tension under which it was working to bring an extra pressure on the journals. It may be written $\Sigma f_t (T)$ where f_t is a constant co-efficient and T is the tension of cable found at any point where such tension was causing additional friction, Σ indicating the summation of all such points. A word now in regard to the laws of this method of transmission of power.

As in the case of a belt, the sum of the tensions on the taut and slack side of the driving drum is constant. If the driving drum were free to move in either direction the tension on each side would become equal. This is called the mean tension, or T_m. When the drum is turned, transmitting a pull to another drum, or as in the case of a cable road distributing it along the line, the mean tension is increased on the side transmitting the pull, and decreased by an equal amount on the other side. These tensions are respectively called T_1 and T_2, and $T_1 - T_2$ is the pull transmitted. For any given arrangement of wraps on the driving drum and a given mean tension, it is apparent that there is a limit beyond which the excess of T_1 over T_2 could not go. It is the point where any excess of pull would cause the cable to slip on the drum. This limit to the value of pull transmitted is given by the well-known equation between the two tensions.

$$\frac{T_1}{T_2} = e^{f\theta}$$

where f is the co-efficient of friction between the materials of the belt and pulley, and θ is the angle of contact, e being the Naperian base. This is the ratio of greatest economy in transmission of power and would be approximated in practice. The above equation gives simply a definite relation between mean tension, or

$$\frac{T_1 + T_2}{2}$$

and the maximum or T_1 as follows:

$$\frac{T_m}{T_1} = \tfrac{1}{2}\left(1 + e^{-f\theta}\right)$$

We will now return to the element of friction due to tension, which was $\Sigma f_t (T)$ and assuming, what would always be very close to the case, that the pull was uniformly expended along the straight reaches we would have T_1 decreasing uniformly from the power station to a curve or depression pulley down the line; also T_2 would increase on the return line the same amount down to this point, so that the sum of the two tensions on the down and up line acting at that point would be $T_1 + T_2$; through the curve it would not be uniform, tension increasing less there on the return line, so that the sum of the tensions would be slightly less at the second curve, etc.; but neglecting this as very small in comparison with the value of $T_1 + T_2$, and considering the summation as embracing the points of a double track road, taken opposite each other, two and two, we may write with little error T_m for the variable tension T at any point. Also if we consider the length of the road taken in an imaginary unit, comprising an average amount of this tension resistance, we may replace Σ by multiples of the length in this unit, from which we have $\Sigma f_t (T) = l f_t T_m$, or in terms of $T_1 = l f_t (\frac{1}{2}(1 + e^{-f\theta}) T_1)$.

Now neglecting here the comparatively unimportant element of local tension that may be caused by starting a car, and T_1 is the maximum tension, to safely bear which the size of the cable must be designed. As will be more fully considered after the strength of a cable is directly proproportional to its cross section, or to its weight per unit of length; using a general constant to express this proportion, we may say $T_1 = c$ (weight of unit length) $= c\,\frac{\text{cable weight}}{l}$, and substituting this value of T_1 in the above equation, and writing for the product of the different constant terms a general constant c_1 and we have

$$\Sigma f_t\ (T) = c_1\,\frac{l\,(\text{cable weight})}{l} = c_1\ \text{cable weight}),$$

from which, as as at first expressed,
$P_2 = f_r$ (cable weight) + c_1 (cable weight) = K_2 where K_2 is the sum of the two constant terms f_r and c_1.

In the above, some small elements of friction have not been considered, as they are thought to be comparatively insignificant, and as their introduction would give a needlessly complex equation. Neglecting these, then, the conditions of this equation may be now stated. For a cable designed to work with a given factor of safety and having an average constant amount of deflection, say one right angle curve per mile, then for all variations either in length or size $P_2 = K_2$ (cable weight), where P_2 is the pull in pounds required to run the cable, without cars, at the given velocity, and K_2 is a constant depending on the type of construction, such as size of sheaves, curvature per mile, etc. Between different types of construction it is, of course, apparent that K_2 will be smaller the less the curvature in the line, also it will be smaller the greater the ratio of diameter of sheave to diameter of journal. It also should be noted that the greater the factor of safety, or, which is the same thing, the smaller the ratio of T_1 to weight of unit length of cable, the smaller will be the value of K_2. So that between roads where not only the type of construction is different, but where the size of the cable is arbitrarily assumed, there is little comparison in the values found for K_2. This is the constant of construction mentioned at the beginning of this paper. Some determination of the separate values of its tension and weight elements and their laws of variation is of decided importance, as will be appreciated further on when we see its effect on efficiency. This determination might be at-

tempted theoretically, but without the guidance of experimental data it would hardly be more than a modified guess, and in this paper I have preferred to rest the matter here. Actual values of K_3 will be considered later.

(TO BE CONTINUED.)

Mineral Exhibition of Peru.

The inauguration of the Mineral Exhibition at Lima, which had been appointed for the 1st. of Oct., 1887, has been postponed until the 29th of June, 1888, by order of the Government of Peru. This change has been made, because it has been found that it would be impossible to complete the necessary preparatory labors by the first named day.

This exhibition, which is to be given in the machinery buildings and gardens adjacent thereto, of the Permanent Exhibition of Lima, is to be under the honorary presidency of the Minister of the Treasury, and will be managed by a Committee of Direction, consisting of nine members named as follows: three by the Government, two by the Municipality of Lima, two by the Managers of the Lima Permanent Exposition and two by the School of Mines.

The object of the proposed exhibition is to display to the world the great mineralogical wealth of Peru, to encourage the development of its mines, and to make known to the people of that country all improvements in mining machinery and tools, as also the advantages to be derived by employing modern methods instead of continuing the very imperfect ways still in vogue in the working of most Peruvian mining properties.

It is intended to exhibit, properly classified and grouped, samples of the innumerable rich minerals and ores of Peru, and likewise of all tools, machinery and modern apparatus used in the working of mines and in metallurgical operations. Manufacturers and inventors are consequently particularly invited to send samples of their various manufacturers and inventions, all of which will be admitted into Peru duty free, and be transported from Callao to Lima by the railway companies without charge.

It is believed that this mineral exhibition will be the means of attracting the attention of capitalists, foreign as well as native, to the great mineral resources of Peru now that peace reigns throughout the country, and great inducements are offered for the investment of capital in mining properties, which will assuredly yield handsome returns to all who may engage in their development.

Manufacturers and patentees of machinery and all kinds of instruments and tools used directly or indirectly in the working of mines and smelting of ores, will undoubtedly perceive that it is for their interest to take part in the proposed exhibition, and make haste to do so.

The diplomatic and consular representatives of Peru have been instructed to afford every facility in their power to all desirous of sending exhibits, and will furnish any further information that may be desired in relation to the proposed exhibition.

"People all along the line quit their shops and fields, and the citizens in the town their different occupations to *aid* in getting the best route."
Atlanta Constitution.

Deflection of a Truss.

I. O. BAKER, PROFESSOR OF CIVIL ENGINEERING, UNIVERSITY OF ILLINOIS.

The writer has just finished reading an article on the above subject, in a late number of an engineering magazine, and as he could not agree with that solution, he offers the following one.

No exact analysis of the deflection of a truss can

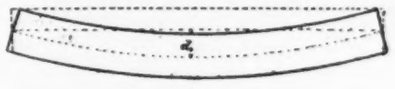


Fig. 1.

be made, but the following approximation is sufficiently exact for all practical purposes. We may take a truss with chords horizontal, compression web members vertical, and tension web members inclined, as a representative; for simplicity also assume that the truss is wholly of one material, and that all sections are proportioned for the maximum stress due to an uniform load. The deflection of such a truss is made up of that due to the chords alone, and that due to the web; approximately each is independent of the other.

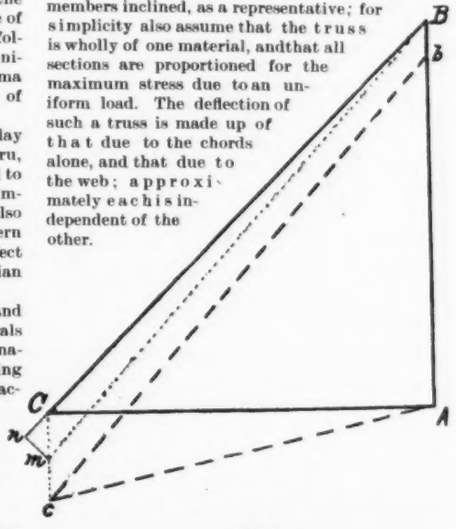


Fig. 2.

The deflection due to the change of length of the chords may be found as follows. Let d_1 = this deflection; L = span; D = depth of truss. We may assume that the center line is bent into the arc of a circle, whose equation is $(\frac{1}{2} L)^2 = 2 \rho d_1 - d_1^2$, ρ being the radius of curvature. Since d_1 is small in comparison with ρ we may put $(\frac{1}{2} L)^2 = 2\rho d_1$; therefore $d_1 = \frac{L^2}{8\rho}$. To find ρ, let e = the elongation or compression of a unit due to the working stress $= \frac{S}{E}$; S being the working strain, usually taken at about 10,000 lbs. per sq. in. for wrought-iron, and E being the coefficient of elasticity usually about 25,000,000 lbs. per sq. in. for wrought-iron; therefore e = about $\frac{1}{2500}$ for wrought-iron. Notice also that the neutral axis will remain constant and be equal to L. Then, since the neutral axis and the lower chords after deflection are to each other as their radii, we have $\rho : \rho + \frac{1}{2} D :: L : L(1 + e)$; from which $\rho = \frac{D}{2e}$. This value of ρ substituted in the previous value of d_1 gives $d_1 = \frac{e L^2}{4 D}$.

The deflection due to the web members may be found approximately by assuming that the chords remain unaltered, and finding the change of form in each triangle due to the change of lengths of the strut and tie forming two of the sides. Let d = this deflection. For greater simplicity, take the right-angled triangle $A B C$, Fig. 2. $b B$ = the shortening of $A B = e$. $A B = e D$; $C n$ = the lengthening of $B C = e$.

$$B C = e. \quad \sqrt{\overline{A c^2} + \overline{A B^2}} = e \sqrt{l^2 + D^2};$$

$A c$ is assumed to remain constant. The triangle $A B C$ takes the form $A b c$, and $C c$ is the deflection of the point C. $C c = C m + m C$, $m c = B b = e D$. Assuming that the arc $C m c$, with center at A is a straight line, we have, $C m : C n :: B C : D$ therefore $C m = \frac{e(l^2 + D^2)}{D}$. Finally

$$C c = e D + \frac{e(l^2 + D^2)}{D} = e D \left(\frac{l^2}{D^2} + 2\right)$$

If N = the number of triangles in the truss, then the deflection at the center due to the web members $= d_2 < \frac{1}{2} N . C c < \frac{1}{2} N e D \left(\frac{l^2}{D^2} + 2\right)$. But since the braces are proportioned for the maximum stress per unit on the web members, the actual stress for a uniform load will be less than S; and consequently the deflection $C c$ of each panel point will grow less as we approach the center, and the deflection d_2 will always be considerably less than the above value, say the $\frac{1}{q}$ part; and, therefore, $d_2 = \frac{1}{q} \frac{1}{2} N e D \left(\frac{l^2}{D^2} + 2\right) - \frac{1}{2} e . L \frac{1}{q} \frac{D}{l} \left(\frac{l^2}{D^2} + 2\right) - \frac{1}{2} e L \frac{1}{q} \left(\frac{l}{D} + 2 \frac{D}{l}\right)$. Notice that d_2 depends upon the relative values of l and D, and the strain on the different web members for a uniform load, *i. e.*, upon q.

For any given case the exact value of $\frac{1}{q}$ could be calculated but such an attempt at extreme accuracy would be useless, since the actual deflection will be due to the elasticity of the material and to the closing up of the joints. The last element cannot be known with precision, and therefore, the deflection can not be computed exactly.

The total deflection, d_1 due to elasticity, is equal to

$$d_1 + d_2 = \frac{e L^2}{4 D} \left[1 + \frac{2}{q} \frac{D}{L} \left(\frac{l}{D} + 2 \frac{D}{l}\right)\right]$$

The first term is the deflection due to the chords, and the last that due to the web. The last term is usually neglected, but this seems of doubtful propriety. q will vary between 1 and 2, being nearer the former the longer the span; therefore $\frac{2}{q}$ will be greater than unity. Also $\frac{D}{L}$ = about $\frac{1}{8}$; and $\frac{l}{D} + 2 \frac{D}{l}$ will always be greater than 3. Hence the last term, $\frac{2}{q} \frac{D}{L} \left(\frac{l}{D} + 2 \frac{D}{l}\right)$, is always more than $\frac{3}{8}$ of the first.

If the deflection due to the web is neglected, then the deflection $= \frac{e L^2}{4 D} = 2 e L = \frac{L}{1250}$, which agrees practically with the usual rule that "the deflection is 1 in. per hundred feet of span." For wooden bridges $d = \frac{L}{600}$ nearly.

Portland Cements.—Tests at Long Dates.*

BY REGINALD EMPSON MIDDLETON, M. INST. C. E.

The accompanying data, derived from the breaking of some 200 briquettes at dates varying from the original seven days' test to 410 days, and from that to 2015 days after gauging, are offered very tentatively, especially as regards the deductions drawn from them, but may not be altogether without interest.

The initial strength of the briquettes broken, that is to say, the strength at seven days after gauging, is by no means high; nor are the final results at any date such as are often secured, the minimum and maximum at seven days being 240 lbs. and 563 lbs. per sq. in. of section; but this may be explained by the fact that the cement was not made to meet any high specification, the grinding was such as to leave a residue of 20 per cent. on a sieve of fifty meshes to the inch, and the gauging was done purposely so as to arrive at the minimum rather than the maximum results; and the same cement in other hands has always given tests from 20 per cent. to 25 per cent. or thereabouts, higher than those from which this statement is deduced. But though it is desirable that these facts should be understood, the comparative lowness of the tests in no way interferes with

*Proceedings Inst. of Civil Engineers.

the general inferences which may be drawn, except that it may be considered that the limit of strength at seven days which gives the best final results may be raised somewhat when cement is tested so as to give out its greatest strength; and perhaps, instead of this figure being in accordance with these results, 538 lbs. per sq. in. of section at seven days after gauging, it may be increased to 650 lbs. or 670 lbs. for finely ground cement. But with this initial strength there is, in these examples, little if any increase in cohesion; indeed, in many cases, there is a falling off in this respect—which is, however, compensated for by an increased strength in some cases. In eleven samples whose initial strength was between 500 lbs. and 600 lbs., six showed a loss of strength amounting on the average to 79 lbs. per sample, or 15 per cent.; while five showed an increase averaging 85 lbs. per sample, or 16 per cent.; or, taking all the samples into consideration, a loss of 1 per cent.

It will be noticed that cement with an initial strength of only 350 lbs. gives equally good results at 1,076 days after gauging with that having an initial strength of 535 lbs. broken 686 days after gauging; and it is not probable that the increase of strength of any cement would be greater during the third and fourth year after it was made and used. All the samples of a less initial strength than 300 lbs., while showing an equal percentage of increase of strength, do not give anything like so good a final result; while above 350 lbs. initial strength the percentage of increase falls off rapidly, so rapidly that the final result is not so good as that having a lower initial strength. These tests seem to point to the use of one of two qualities of cement, namely, either that giving the maximum percentage of increase in strength, or that showing no increase at all in say three years in each case, the two qualities of cement being represented in the above samples; the first by that having an average initial strength of 330 lbs. per square inch at seven days, and the second by a cement having an initial strength of 535 lbs. at the same date after gauging. It is a nice question which to prefer, and the user must be largely guided in his decision by the purpose for which the cement is to be employed, whether the material can wait for the added strength to accrue. If this be the case, there seems to be little doubt that the cement, having a comparatively low initial strength with a large percentage of increase should be preferred, for such a cement is decidedly more reliable, and there is no fear of its containing an excess of lime. The figures in brackets are those which may be considered to represent the full strength of the cement if tested in the most advantageous way, and are found by adding 22½ per cent. to the original figures.

Initial strength.	Average strength at 7 days after gauging.	Average date at which samples in following col. were broken.	Average strength.	Absolute increase or decrease in strength.	Average increase or decrease in strength per ct.	Average increase or decrease in strength per c. per member.
lbs.						
240 to 300	260 (318)	1463	430 (527)	+170	+65	+1.33
300 to 350	330 (404)	1076	545 (667)	+215	+65	+1.80
350 to 400	371 (454)	1595	469 (574)	+ 98	+27	+ .51
400 to 500	446 (546)	1054	459 (562)	+ 13	+ 3	+ .09
500 to 600	535 (655)	686	530 (649)	— 5	— 1	— .04

The Brooklyn Eagle on the Brooklyn Bridge Question.

The following leading editorial appeared in the Brooklyn *Eagle* of Saturday, June 11, in relation to the Brooklyn Bridge question, and the recent action of this journal, and others in regard to it. We omit some personal references.

A MISTAKE TO BE AT ONCE CORRECTED.

There has no question arisen for a long time past involving greater interests of this city than that the method by which the transport of passengers over the East River Bridge shall keep pace with the progress of population and the growing demands for a prompt, economical and safe interchange of travel between the two points. It is not likely that another bridge, certainly not one uniting the present centers of traffic of the two cities, will be built for many years yet—if ever; and it behooves us to avail to the utmost extent possible of the capabilities of this costly structure, that the day for its necessary duplication, if that day is to arise, shall be as far in the future as possible. Impressed with this view doubtless the Board of Trustees of the bridge has from time to time evinced a commendable earnestness in adding to the conveniences for accommodating the ever increasing travel—which has now outgrown the public expectation to such a degree as to render any calculation for the future measurably a matter of guess work. But in their zeal (we cannot but think "untempered by knowledge)" they have lately shown their inability properly to grapple with this question, which is so far a purely technical one that the business man merely could rarely be relied upon to reach a just solution.

Two of the New York trustees, actively associated in supplying metallic structural material, invite an outside engineer, with no special experience, so far as we can learn, on the subject of cable traction or railroad management, in general, to present plans for adding to the capacity for travel of the bridge. In view of the possible demand on this bridge, foreshadowed by the increase of travel from year to year since its opening, it was to be expected that the maximum which it was possible to be accommodated by the bridge would be provided for. But the plan presented, so far as the published report is to be taken as evidence, proposes to dispatch trains of but six cars, where four cars were previously used; involving, however, a change in the present system of operating.

Without discussion of any importance or a reference to their own engineer for report, who might be supposed to know, if not more, certainly as much of the necessities of the case as a casual visitor to the bridge, the Board of Trustees, by a unanimous vote, not only adopted this untried plan, *nem. con.*, but appointed the originator of it as the engineer under whose auspices it was forthwith to be put into execution. This most unseemly haste on the part of the trustees was not warranted by any emergency to forbid, or render inexpedient, the loss of a few days spent in investigation, and was in marked contrast with the conservatism which has hitherto characterized their proceedings as selected custodians of an important trust; and it is but charitable to individual members of the Board to suppose that implicit confidence in the purity of motive of their brother trustees misled them into surrendering their individual judgment into the hands of those they have been led to regard as their professional advisers in matters in which they themselves could not be supposed to be competent. It is to be hoped that their late action admits of reconsideration.

The editor of ENGINEERING NEWS showed very clearly in his issue of June 4, and again shows in the article from his columns to be reprinted in the *Eagle* to-morrow, the danger to be apprehended and constantly impending and but awaiting the coincidence of circumstances sure to occur sooner or later in this proposed method of working the bridge cars, and which no presumed benefit growing out of increased capacity will for a moment justify. The illustration of this does not admit of intelligent explanation without the aid of diagrams, nor is it a matter that the average reader could fully understand, it being, so far as we know, without precedent in practical engineering and therefore properly relegated to the expert in kindred branches of practical mechanics. Nor is every one who may be entitled to write himself civil engineer thereby qualified for the expression of an opinion on this subject; but the special set, who has had to do with moving masses under high velocities and other varying conditions, alone has a right to be heard in this matter.

Mr. EMERY, in an interview growing out of the late criticisms of ENGINEERING NEWS, sought to make it appear that the unfavorable comments in the NEWS applied more properly to a preliminary plan designed for immediate use, and not to the completed plan, as intended for permanent use on the bridge in the future. If this be so, we have an additional element of uncertainty to speculate upon.

By what principle are we expected to accept the hasty decision of the trustees as to the competency of plans which they had never seen in their entirety, and of the working of which they could have had no knowledge, beyond a blind faith in some authority? And we may fairly ask, Who was this authority?

The present method of operation on the bridge is measurably safe, and can be made, by well known expedients, absolutely so, but for lack of extension room it is limited at present to enable trains of four cars every 90 seconds. The plan lately adopted by the trustees, is understood to secure trains of six cars; the time we are to state precisely but by the analysis in ENGINEERING NEWS it is in excess of what is now required and with an unquestioned element of danger added, which sooner or later will manifest itself to the discomforture of all concerned. Query: Is it worth while to risk so much for so little gain? Contrast this with the plan proposed by ENGINEERING NEWS, by which, with absolute safety, twelve cars or *more* are handled, with an insignificant addition of time, in each train, thus *doubling* the capacity for future travel over that now proposed. It is true that this cannot be effected unless by an expenditure of money for land at the termini; but, with an investment already made of $14,000,000, to hesitate at a trifling expenditure in order to reach the ultimate capacity of this magnificent structure would be a blunder which will reflect upon everyone who has had to do with such a miserable pennywise policy as appears to be contemplated.

The *Eagle* lately elicited from Colonel J. W. ADAMS, the celebrated engineer so historically related to the genesis of the bridge, the statement that he has crossed and recrossed the bridge nearly every working day since it was opened, and has studied its necessities in the light of the experience acquired by some twenty-five years of practice in railroad matters, including good personal service on the foot board of a locomotive engine, and he is certainly qualified as one who knows whereof he speaks, to affirm, as he does, without any reservation whatever, and as to which he is willing to put himself on record, that there is no possible method whereby the full capacity for passenger traffic by cable can be attained on this structure, comparable, in point of economy, efficiency, and above all, safety, with the circulating system as proposed by ENGINEERING NEWS, which is acknowledged as an authority on the subject of railroad needs and management second to none in our country.

This brings the *Eagle* to the last point, and one for which it would ask more attention than the subject has hitherto received. Brooklyn is at present the third city in the Union, and soon to take the second place, with a structure in her midst which in its reputation carries her name to the ends of the earth. She is yet content to have the approach to her giant bridge resemble nothing more dignified than a shingle palace done in iron, rivaling in no essentials, save dimensions, the ordinary store front pattern, in design and detail too contemptibly insignificant to admit of architectural criticism. It has but the one redeeming merit—that it will require only a couple of weeks' work to sweep the whole thing away, without detriment to the bridge itself, and with a manifest increase in the scrap heaps of the city work shops; giving place to something less ephemeral, which would be a commanding feature in the architecture of the locality, not to be overlooked, and bear some relation to its unrivaled surroundings, and the purpose of the erection.

This transformation the circulating system as proposed by ENGINEERING NEWS would permit, indeed call for, beyond that of any other which has been proposed, and we feel well assured it will one day be realized.

The day before the following article appeared in the same paper:

GO BEHIND THE RETURNS.

The new Board of Bridge Trustees will hold its first meeting on Monday and elect officers for the ensuing year. Although there has been but one change in the membership, the substitution of Mr. CHAS. S. HIGGINS for Mr. EDWARD ANNAN, the Board is beginning a new term of office and has an opportunity to make a new record. The members have been reappointed under peculiar circumstances. Those from Brooklyn have been again chosen because the Commission, consisting of the Mayor, Controller and Auditor, speaking for the city and the public, is convinced that the interests of the greatest highway in the world will be best subserved by their retention in office. The citizens of Brooklyn are satisfied with the present management and its ability to furnish facilities to carry the enormous mass of human freight in safety.

It is safe to say that though New York paid one-third of the cost of the bridge, that city does not have one thirtieth of the interest in the structure that Brooklyn has. While an inappreciable fraction of New York's population ever gives the bridge a thought, every person in this city is vitally concerned in the welfare of the highway. For this reason the Brooklyn members of the Board of Bridge Trustees are peculiarly responsible for the management of the structure, the safety of the passengers, who are nearly all residents of this city, and the disposition of the receipts.

It is, therefore, clearly the duty of these gentlemen to reopen the question of terminal arrangements at the New York station, which was so hastily considered at a special meeting two weeks ago. The most important subject since the initial conception of a bridge across the East river, is now before the trustees. It should be openly discussed and the proposed plans thoroughly examined before adoption. The elusive resolution giving almost unlimited power to two closely associated New York City trustees should be recalled and the whole Board should shoulder the responsibility for the improvements. During the past week the *Eagle* has published criticisms upon the plans showing that the promoters refuse to defend them before the public. This, in itself, is enough to demand the reconsideration of the subject by the entire Board, who can hardly bear the burden of allowing two men to spend several hundreds of thousands of dollars in the application of a system of doubtful value and safety. If the plans are worth anything they will bear close scrutiny and this is what they should receive.

Construction and Management of Water-Works.*

The subject assigned to me presents a variety of heads or points of interest that might be developed to a volume of no mean dimensions, but I shall only scan them lightly, or your patience would be exhausted.

I would notice:

1st. A system of good works.

2d. A corps of efficient workmen.

3d. A compensation to workmen that will stimulate interest in the work.

4th. The care and protection of main pipes and gates.

5th. The care and location of hydrants to make them efficient for fire service.

6th. The examination of services to see that there is no waste of water.

7th. Protection of the supply.

8th. Duties of the Superintendent, and the relation which should exist between himself and the Board of Water Commissioners.

9th. Relations of the city or town government with the Commissioners or Superintendent; and

10th. The good results which will follow when the officers of the works are properly endorsed by the city or town officials.

Among and from the systems in use, my preference would be for a gravity plan, even at greater cost than others. My next choice would be a pumping station and reservoir. Then, direct pumping, or what is known as the "Holly System;" but under any and all circumstances, a system of water-works in every city, town or village, where pure water can be obtained.

For the past eight years it has been my fortune to have charge of a system of water-works that combines, practically, all of these complications, and pumping by water power, so you will pardon me if I assume to speak of any situation that could be called for in a system of water-works, and shall presume that every place has a good one.

Careful consideration should be given to the proper location of the mains. The size of mains should be considered, and should be not only adequate for the

* A Paper read by Edwin Darling, Supt. of the Pawtucket Water-Works, at the annual meeting of the New England Water-Works Association at Manchester, N. H., June 15-17, 1887.

present demand, but should anticipate the wants of the future for at least a generation to come. A great mistake is made by many cities and towns in putting in mains insufficient to supply even the present demand, from a mistaken economy of expense. Now, I assume the ground that no city or town can afford to stint the supply or efficiency of its water-works. It should be liberal, in the size of pipes, location of hydrants, gates, and especially so in the number of hydrants, for here comes the important part of water-works. Convince the citizens of any city or town that you have a good fire protection, and the water-works become popular at once. To secure such protection the mains must be of sufficient capacity to supply any demand, and the elevation of water must be such as to produce a pressure of 70 or more pounds to the square inch. The location of the pumping station, if such is required, has much to do with the efficiency of the water-works, but it will be allowed that more depends on the pumping engine. Many cities and towns curtail the efficiency of their works by furnishing an engine of capacity barely equal to the present demand to save expense. True economy will put in a much larger engine than might possibly suffice for the time, for it is the universal experience of all water-works that the capacity of the engine is the first to be exhausted. Here let me enforce the importance of a *good engine*, and of sufficient capacity at the beginning of the work. I could enumerate many works that are in need of larger pumping engines to-day, where it was thought they had sufficient pumping capacity for a much longer time than had passed since their works were built. Practical experience shows that water-works grow in demand much faster than the most sanguine projectors anticipate, and it is impossible to err when you build largely in excess of the present demand.

The employés should be men of good habits and unvarying courtesy. To illustrate—take the Water Registrar or clerk in the office, if he does not need the patience of a Job, may I ask who does? With the thousand and one questions he is asked, with the knowledge that is forced upon him by being informed how small the family is; the beautiful well situated, perhaps, just beyond the cesspool, and the splendid large cisterns connected with the premises, making it impossible to use but very little water. All this stock of information he is expected to believe and treasure for future use in adjusting the bills, and he requires a degree of fortitude known best by those having the experience of the situation.

I think my friend, B. F. JONES, Superintendent of Kansas City, when he inserted in "Hints to Water Consumers" the following statement: "In making contracts for use of water, it is only a waste of time to state how small the family is, how large the cistern is, or what a small amount of water is required. If these details are omitted, it will be considered in making water rates that all families are small, that *every one* uses less water than any one else, and that every house has a splendid cistern," realized the situation that the registrar or clerk is placed in. This is but one case, and leaves the thousand to be met with that courtesy known only to those who hold these positions.

Again, the inspector of meters and service pipes must be a man of courteous department, a gentleman and a scholar, or he will meet with sudden rebuffs if he does not approach his busines and subject with a great deal of caution. Most of you remember the experiences related by our friend WALKER a few months ago

The service pipe foreman and his men must be very polite and affable, for should they begin to dig in a street, generally six or eight "Sons of Rest" want to know what is to be done, and why, what for, and why it is not done some other way; how much water is to be used, what it will cost, and if it could not be done at night so as not to obstruct the sidewalk in the daytime; and every new one that comes that way must be quietly and civilly answered the same round of questions, and should some ambitious reporter happen along, he will publish the necessary instructions the next day, but too late to assist in the matter?

The corps of men at the pumping station should be first-class workmen, and the engineer in charge, the responsible party, holding, as he does, the key to the situation, should have full control of all, and realize that his integrity is at stake. The best feelings should exist between the engineer and his subordinates, and each should feel that he has a duty to perform and each take a pride in performing it. A system that requires a place for everything and everything in its place, with neatness, should be established in the beginning and maintained to the end as regards everything in or about the station, and no employé should so far forget his duty as to leave undone that which has its time and place to be done. Courtesy should be extended to all visitors.

A water-works, to the business mind, is looked upon in the light of a machine shop or other mechanical works, but the practical workings are far different. While the laborer in the shop or factory finishes his labor with the expiration of ten hours, the superintendent, the engineer and his men at the pumping station know no time for a day's work. Certain work is to be done, and it is to be performed without regard to time. The service pipe department is liable to be called at any time—by night as well as by day—thus placing those employed on a water-works under different situations than men employed in mechanical pursuits, and they should receive a compensation which will make them feel satisfied with the position, and so encourage them to perform their duties to the satisfaction not only of their employers, but to themselves and the public.

The care and protection of main pipes depends largely upon the manner in which they were first laid in the ground. If cast-iron pipe of proper weight is used, and laid at a proper depth, (which in New England should never be less than 5 ft. below the surface,) and properly caulked at the time, then but little care will be required. On the other hand, if any of these requirements are neglected, the amount of labor and trouble is only measured by the circumstances of pressure, weather and chance.

Gates or valves should be examined twice or more in a year, and shut and opened and the stem oiled, if possible. Hydrants should be examined at least twice in each year to see that they are in working order. The difference in make and pattern of hydrants leads to a different mode of inspection and different seasons of the year, and is especially affected by extreme depth of frost,—for then comes a time when the superintendent is held responsible for that which no human eye can see. To open hydrants in extreme cold weather simply to see if they are frozen, is, to say the least, dangerous and should be done only with the utmost caution. When the ground is frozen 3 or 4 ft. in depth, the frost produces results which no human mind can foresee, and there may be a chance of finding a small per cent. of hydrants frosted.

There should be a thorough house to house inspection at least twice a year, even with a liberal supply of meters, but where the supply of meters is very limited. I would keep the inspector on the road all the time. This costs money, but prevents waste: that is to say, prevents it just about the time the inspector is there or expected, after he is gone the wilful waste goes on as usual.

This opens the great question of waste of water and how to prevent it, which is being discussed not only in this section, but wherever water-works have been established.

The magnitude of the question has puzzled great minds and must be left to men of science, though some suggestions may not be out of place, and make a basis for thought and inquiry that shall prove a benefit to those interested. One very gratifying fact in regard to this problem, is seen in the increased use of meters in cities where waste was assuming dimensions that demanded immediate action, and that in proportion to the introduction of meters the enormous waste has, in a measure, been checked, and many as well as myself believe that here lies, at least a partial remedy. A comparison made some few years since between a few large cities as regarded consumption and revenue, showed about 60 per cent. of consumption in favor of meters, and from 200 to 300 per cent. of revenue in favor of meters. With these statistics, based on facts and figures taken from their own reports, it is safe to urge the adoption of meters in all cases to stop the waste of water where the circumstances will allow, even if at first view it might not seem practical.

The supply demands careful inspection, and continual watchfulness that no contamination be permitted, for this is not only the stock in trade, but the reserve fund, and must be guarded with jealous care, and every innovation be promptly met, even to calling on the law for protection.

The State of Massachusetts has appointed a State Board of Health, having in its charge the sanitary question, which promises grand results, and to which all superintendents are invited to contribute information, and their aid and assistance is asked in the great work, and should be cheerfully granted.

The Superintendent should be a man whose whole mind is devoted to the work, but it does not follow that he must be able to affix C. E. to his signature, provided the services of one can be obtained at his convenience or in his need. He should be responsible for any detail in or about the works, therefore should not be expected to perform much manual labor, yet to my own knowledge, there are many in New England that do. The relations existing with the Board of Commissioners should be such as to assure him of its confidence, and that his efforts are duly appreciated. This will encourage and stimulate him to faithfulness, and enable him to perform his labors with a degree of ease and ability. He should be allowed to employ such help as is best adapted to the labor required, without any party or political prejudice, and he alone is able to judge and decide what is needed. Many cities and towns make the department a political pot, to be boiled at every election of officers.

As the water works is generally the only department that produces a revenue to the city or town, it should be conducted strictly on business principles. What corporation or manufacturing company makes radical changes of superintendent or employés every year at the annual election of officers when the work has been satisfactorily performed and results produced that are satisfactory to the company or corporation?

A great mistake is made by any city or town that allows politics to enter or hold rule in the Water Department. The motto in selecting the Board of Water Commissioners should be, "The best man for the place regardless of political opinion," and having so selected the board, they should be fully endorsed by the city or town government, and held strictly responsible for the department. They should have full control, and it should be their duty to manage, oversee, run, and have the sole and exclusive care of the works, make extensions of mains, or otherwise increase the efficiency of the works: provided, always, that they shall not incur at any time any debt on account of the works in excess of the appropriations which will be from time to time made therefor.

Water-works conducted on the foregoing plan cannot fail to produce results which will be endorsed not only by the city or town officials, but by the citizens and tax-payers at large.

There are at the present time many water-works in New England that can be enumerated which are conducted on this plan, and when results are compared with works conducted on a faulty plan, the difference is too marked to need comment.

TECHNICAL NOTES.

THE 450 incandescent electric lights recently put into the Hoosac tunnel are giving so much satisfaction that an order is to be given increasing the number to 1,750.

THE latest proposed tunnel in the Rocky Mountain region is to run under Gray's Peak, at an elevation of 10,000 ft. above the sea and 4,441 below the summit of the mountain. The tunnel would be about 25,000 ft., long and shorten the distance between San Francisco and St. Louis by about 300 miles. Gray's Peak is about 60 miles due west of Denver, Col., and is said to be at the narrowest point in the Atlantic and Pacific divide.

AN engineering correspondent of the New York *Tribune* who pleads for a bridge over the North river, makes the interesting statement that: "No fewer than 185 trains of passengers arrive at and 189 depart from Broad street station, Philadelphia, every day." There must be a large stock of spare locomotives and cars on hand in that station, to keep this up for any length of time.

THE use by old Roman architects of volcanic scoria or pumice as a filling material for vaults and spandrils is a practice that might be profitably copied in our own day. The vaulting of the corridors of the amphitheatre at Catania is so executed, and so is the dome of the Pantheon at Rome. These structures have stood the sieges, earthquakes and various other causes of damage and decay for many centuries. Coke is a somewhat similar material and might be used as a substitute for the often rare pumice.

A. E. OUTERBRIDGE, Jr., in a late lecture before the Franklin Institute, exhibited castings in hard iron reproducing with great sharpness the surface of lace and embroidery. The lace, etc., is first carbonized by being placed in a cast-iron box, the bottom of which is covered with a layer of powdered charcoal; then another layer of carbon-dust is sprinkled over the object, the box closed and heated gradually in an oven up to a white heat and kept there for at least two hours. This carbonized substance is then put in an ordinary "green-sand" mold with the edges of the fabric extending beyond the mold so that it is held fast when the mold is closed. As the molten metal flows into the mold it forces the fabric firmly against the sand wall and by the affinity of iron or steel for carbon an exceedingly sharp casting is made that can be used as a stamp for a variety of purposes. The carbonized lace, leaves, grasses, etc., are not destroyed and several castings can be made from the same object with a little care.

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EDITORS.

GEO. H. FROST, - - - BUSINESS MANAGER.

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A MOST important and, we hope, decisive step in advance towards the solution of the car-coupler question has been taken by the coupler committee of the Master Car Builder's Convention. This is the earnest recommendation that the association adopt the JANNEY car-coupler as the standard of the association; it being understood that all other couplers working on the same principle and coupling properly with the JANNEY, should be regarded as equivalents therefor.

How large a part the formation of the committee now acting in this city may have had in leading the Master Car Builder's Association to such unprecedentedly prompt and definite action we cannot say. No doubt it had a good deal of influence. We earnestly hope there will be no further failure to act since delay means dozens of lives and hundreds of injuries every month, and there is no more need for delay. We cannot this week discuss the very important consequences which may flow from this action.

THE old Board of Brooklyn Bridge trustees were all re-elected last week, with one important exception. The radical changes which were on the cards did not materialize. The new Board met on Monday last, and after re-electing all the old officers, and acting on the appointment and discharge of some policemen—formal action by the whole board being required, and exercised as to these bits of petty patronage—took up and reconsidered the authority granted to a committee of three "to immediately proceed with the execution" of a plan for radical changes in the structure which they had never heard of 40 minutes before.

Mayor WHITNEY began by inquiring if the Board "had concluded to adopt the plan presented at our last meeting." He thought the matter was still open for consideration. It occurred to him that they had not heard from Chief Engineer MARTIN, and that it might be as well to do so. The same thing has occurred to a good many other people. He saw in the public press that there was some other and much better plan than suggested. Mr. BUSH remarked, presumably with a wink, which is not reported—that the former resolution provided for further consideration. Mr. CHARLES MACDONALD remarked, that as the subject was "perhaps the most important which has come before the Board," the committee had given it very careful consideration; that "while the general plan was sketched out" to the Board "it was not worked out in detail," and then added the amazing declaration that "the committee—and I think I now speak for all of them—considered that they did not have the power to put this plan into immediate execution," (which was granted them in express words), "before carefully considering it in all its details." He added that "all possible objections have been taken into consideration, or will yet be. A great many objections have been raised, and they are all being considered," and that "the Board need not fear the committee would undertake to make any great change without a most thorough and exhaustive examination, under a full and concise report." Mr. BARNES asked "if the committee would receive instructions from the Board *when they have determined on final plans*?" Mr. MACDONALD cautiously answered that he was "only one member," but he could safely say they "would be perfectly willing to receive any *suggestions* the Board may care to offer." Mr. BARNES then commented on the "terribly dangerous features which they wished especially to defeat," and some considerable discussion of where the permanent Brooklyn terminus was to be, followed, which was ended by Mr. MACDONALD remarking that, as one-twentieth of the Board of Trustees, he "did not propose to retard the committee," of which he is one-third, "by voting where they should cut the bridge off," —a bit of abnegation which seemed to take the Board all aback, so that a motion that the Committee prepare a report to lay before the Board for final action, was carried without further comment.

Adjournment immediately followed, and then began a rather heated colloquy between some of the members. Thus this important question is at last put in the way of being settled decently, and in order; the first step necessarily being to await a report from the existing committee, although this formality was not adhered to in regard to the former committee, which had neither reported nor been discharged, if we are correctly informed, when the present one was appointed.

THE accident at Pownal, Vt., on June 7, is a good example of the uncontrollable eccentricities of facing point switches which it has been so lightly proposed to introduce on the Brooklyn bridge. The train was a long one, and the engine, baggage, express, mail and smoker and two day cars passed over all right with *the rear* half of a succeeding Pullman; but the front half concluded for some inscrutable reason known only to itself to take the side-track. With one truck on one track and one truck on the other something had to give way or the car upset, and it upset, injuring 11 persons in spite of the prompt application of the air brake, and narrowly missing a more serious catastrophe.

Here there is every evidence that the switch was all right, as switches go. The trackmen claim this, and the switch was left behind on the ground to support them, but it was long since an old story, that with every care that can be taken at such points derailments are far more likely to occur at them than elsewhere, and very often for no discoverable reason.

What might have been the consequence had all these cars had hold of a cable, and had another train been due to take their place on that switch, is a more profitable than pleasant subject to consider. It can be shown very clearly on paper no doubt, that such things need not occur, but unfortunately they do occur, and not unfrequently, which has led to their prohibition in all well managed double-track roads. The New York Central had a great many of them a few years ago, and had a number of bitter experiences in consequence, which led to their very rapid removal, and we believe there are none now left. In view of these facts, it should not need even the suggestion that to introduce them on the Brooklyn bridge would be almost criminal carelessness.

THIS note was hardly written when news reached us that the New York Central had again suffered from a facing point switch by another accident at Spuyten Duyvil very curiously similar in all its details to that just narrated. In this case, however, the facing point switch was practically unavoidable, being located where the line to the Grand Central terminus branches off from the old line which continues on along the Hudson river. The accident is thus described by the daily press:

"The train was composed of an engine, four baggage cars, one coach, and seven Wagner sleepers. The leading cars and one sleeper followed the engine, as did also the front truck of the next sleeper, the Trinidad, but the rear trucks shot off down the line leading to Thirtieth street, pursued by the five rear sleepers. The result to the train from the peculiar accident was unique and dangerously interesting. The Trinidad had become a connecting link between two express trains, one bound for the Forty-second street station, and the other for a point several miles distant. An instantaneous photograph would doubtless have suggested the juvenile game of 'crack the whip.'

"There could be only one outcome of such a condition of affairs—something had to give way. The forward part of the train pulled the Trinidad along in one direction and the rear cars shoved it in another until the coupling snapped. The sleeper was dragged to a position at right angles with the river and between the two branches, where it lost its equilibrium and rolled over on one side. The detached rear portion of the train, headed by the sleeper Gibraltar, the forward trucks of which had left the rails, bowled along the west branch, threatening to leap into the river. A telegraph pole was all that prevented that outcome. The pole snapped like a pipe stem, but before it broke it stopped the cars."

This accident occurred about 7 A. M. At 2 P. M. on the same day a second collision resulted with a part of the wreck, which illustrates the confusion inevitably resulting from such occurrences.

Fortunately no very serious consequences resulted, the only person injured having been Mr. WM. H. BOARDMAN, the business manager and chief proprietor of the *Railroad Gazette* of this city, who was somewhat cut about the head, but all the conditions were present for a first-class catastrophe, and absolutely no explanation appears to be possible except that it happened so. The newspapers, indeed, indulge in various *ex post facto* explanations, bent axle, bad wheel, imperfect switch and so on, but each gives a different one and there is no evidence to support any one of them. The rail is the heaviest in America, the switch was interlocked, sleeping car wheels are almost invariably well looked after and no defect was found after the event, all the switches in the neighborhood, as we have happened to be able to observe, are of the most approved pattern and in perfect order, the speed can hardly have been much above 10 miles per hour (the rules requiring 8, we believe) as shown by the slight damage which resulted. All the evidence indicates that had the train been stopped before reaching the switch and both been carefully gone over not a single defect would have been discoverable by the most minute inspection. The derailment simply happened as tens of thousands of similar derailments happen every year from no explainable cause, and multitudes of the accidents which are afterwards explained as due to "spreading of rails," "bad frog,"

"bent axle," etc., really happen in the same way, but are explained as they are because the effect is taken for the cause, no other appearing.

IT is also stated that a similar accident had happened in the same yard on the same day to a freight train.

The aggravating effect of a cable in case of such a derailment is evident since it adds an almost irresistible force to that stored in the train itself to impel the derailed train forward; yet this possibility is only one of the minor objections to the plan recently adopted with such unseemly haste.

As the second thousand of the "Economic Theory of the Location of Railways" goes to press in a few days, the author will be obliged if any one who may have detected typographical errors will notify him of them promptly, that they may be corrected in the plates.

Black-balling in Engineering Societies.

The National Car and Locomotive Builder makes in its May issue a very just and a very well put comment on the "Lesson to Engineers," which we found in the Bussey bridge disaster in our issue of April 2, 1887, and which led us to express the hope that "the time will soon come in this country, as it has already in England, when it will be impossible for a man to earn his bread in responsible engineering capacities unless he is a member" of the only national organization of civil engineers which now exists or is likely to.

Our contemporary comments as follows:

"We believe that engineering science, public safety and morality, would be promoted by a requirement that all engineers competent to carry out important works, should belong to some organization where recognized ability was the shibboleth of admission, and where membership would be regarded as a sure guarantee of competency; but we feel sure that the American Society of Civil Engineers, as now constituted, is not the organization to exercise this species of honorable control. To exercise its power beneficently, the society guarantee must be so constituted that competency, high ability, and leading engineering talents, should obtain easy admission, and the applicants having the opposite characteristics should be rigidly excluded. The warmest admirers of the American Society of Civil Engineers will scarcely assert that it now possesses these essentials to performing the required duties properly. There is no reasonable doubt but Mr. HEWINS would have been admitted to the society before he built the Bussey bridge if he had chosen to make the application, unless he had already made some personal enemies in the society. He could have certified, in the way of qualifications, that he had been engaged in bridge building for thirteen years, and that he designed the longest draw-bridge in the world.

"The American Society of Civil Engineers, like every other society that admits or rejects by a secret ballot, takes in some men who are no engineers, and rejects men who would be a credit to the society as they are to the profession. It is idle to say that the black-ball is used only to reject men who ought not to be admitted. It is constantly used, in all societies, to gratify personal spite; and while such an engine of injustice can be used to keep an able man out of a society of engineers, that society has no right to be regarded as holding within its fold all men worthy of receiving important engineering employment. We could name able engineers who have been engaged in carrying on many highly important engineering works, men who have designed and built great bridges, constructed railroads, where engineering skill of a high order was essential, conducted the execution of costly and imposing water-works, and been the chief engineers in such undertakings, yet they could not gain admittance into the American Society of Civil Engineers, because mean, incompetent men already in the Society, to whom they had at some time done justice, would take care to keep them out. By all means establish a society of competent civil engineers, but do not put it in the power of the sneak to secretly strike, and without cause or explanation keep good men out."

That the secret black-ball is in fact abused in precisely the way that our contemporary notes is beyond dispute. The number of black-balls is small, but every year there are some, and the higher up a man is in his profession, the more likely he is to be black-balled. Every member who keeps the run of the society candidates, knows that instances of conspicuous and gross personal injustice, are continually happening;—that is to say, there are several every year, although the percentage of such is small. That the evil is a great one is generally felt, and that until it is cured the *prima facie* evidence against a man because he is not a member of the Society amounts to nothing, we admit. Except that we were unwilling to extend our article so as to include what was after all a sub-issue, we should have specifically taken very nearly the position of our contemporary.

But on the other hand it is beyond question that the black-ball does have the effect, in frequent instances, of excluding unworthy candidates, and we may add further that the principle of the black-ball, by which a candidate may be rejected without having it generally known by whom he is rejected, is indispensable to the enforcement of any real standard of membership. The problem therefore is to devise some means by which the present great disadvantages may be eliminated without losing its advantages, which appear essential for the welfare of such a society.

It appears to us that this result might be accomplished by giving a black-balled member the right to demand a ballot before the Board of Direction and ex-Presidents of the Society, as Fellows and Honorary Members are now erected. If it were announced on the present candidate lists that such and such persons, "proposers," (naming the original proposers) had demanded such a ballot, the name of the rejected candidate would not be made unpleasantly conspicuous, and it would then be obligatory on those who had rejected him to satisfy some one director or ex-president that there were just grounds for a black-ball, one vote only being necessary to exclude in that case. This would afford reasonable protection against malicious black-balling from personal spite, while preserving the undoubted advantages of the present system.

For it must not be forgotten that a man may conscientiously and properly vote against a candidate for reasons which he is unwilling to publicly announce. Precisely what grounds are sufficient for such action is a delicate question. In a merely social club the old time-honored reason is enough:

> "I do not like you, Dr. Fell,
> The reason why I cannot tell."

In a technical organization it is quite different. No ballot can be justly cast against a man for any less cause than one which makes him unfit to practice as an engineer, such as professional incompetency, dishonesty, habitually drunken or otherwise offensive personal habits. The candidate has a right to protection against exclusion for any less or other motives, since it must be not only a personal mortification to him but a professional injury, if an engineering society succeeds in the aim of including in its membership all, or nearly all, of those of sufficient standing as engineers. And no motive for black-balling is an honorable or proper one which a man is not willing to state in confidence to some one of the higher officers of the society, to be selected by himself, and which does not convince the latter that he acted rightly. Therefore, his previous black-ball should be counted null and void, unless he does this on demand.

In the Institution of Civil Engineers there is no general ballot at all, and the formal ballot at the meetings amount to nothing since it requires one-fifth of the votes cast to exclude, a number which is rarely, if ever, reached. Practically, the election is decided by the Council, a much larger body than the Board of Direction of our American Society, consisting of 20 men. There is therefore not the same difficulty as here, but with some modification like the one suggested, our system seems in many ways the best. In all justice and reason some such modification should be made.

The Elevated Railways of the Future.

The communication in another column signed "stranger," which is from an engineer well qualified to form an opinion, who would be no stranger to most of our readers were we to give his name, makes a suggestion which is new to us, at least, and which we think will be generally considered to have elements in it worthy of consideration. Mr. W. HOWARD WHITE sent a communication to the *Evening Post* recently, suggesting something of the same kind, to the effect that a suitable rapid transit railway should be carried high enough above the streets to entirely clear all ordinary buildings. The additional suggestion to boldly take the bull by the horns by erecting only one pier per block, and that in their middle, and carry the span clear across streets and houses and everything else, seems at first sight a rash proposition, but the more it is considered the more reasonable it will appear, we think, both technically and financially.

There is a fascination in getting something for nothing which none of us can altogether overcome, and while there are vacant streets still left in New York which persistent beggars may get for nothing, we presume it is idle to hope that projectors will cease casting hungry eyes at them, and betake themselves to what really offers far greater opportunities for profit, the construction of a thoroughly adequate rapid transit system, which shall be such in fact. Only when the last hope of grabbing the streets is gone will projectors turn to this more hopeful resource. Therefore, out of kindness to them as well as to the public, their hopes cannot be taken away too soon.

Three arguments of great force favor a very high grade for a rapid transit line. First, so far as public convenience is concerned, elevators make the height of track a matter of indifference. It is more than questionable if free elevators would not be profitable to the present elevated lines at a large proportion of their stations, even with their present low elevation. It needs but a very few extra passengers a day to pay for the expense. Elevators once put in, whether the lift is 20 ft. or 120 ft. matters little to either the public or the company. Secondly, it is mathematically demonstrable that the cost of a long bridge is at or near its minimum when the cost of the piers and the cost of the spans are equal to each other. If we figure in with the cost of the piers the enormous cost of land to put them on it is at once evident that to bring about anything like such an equality we must have spans of very considerable length, and place the piers on the cheapest available property, which is plainly the back yards of buildings fronting on the street. Thirdly, it is a fact that, for a bridge or iron trestle of given height, the cost is very slightly affected by the spans. There is a span which is most economical, but very large variations either way make but trifling differences in the total cost. What is lost in the spans is saved in the piers. Again height is comparatively inexpensive in all bridges. The top and bottom of the structures—the spans and foundations—are practically the same, and they are by much the larger part of the whole. The

little additional masonry needed to lift the structure to twice the height may amount to a large sum absolutely, but comparatively it is a small matter.

We feel strongly inclined to the opinion, therefore, that when everything is considered the high structure of long spans will be the one which will best meet all conditions, including the fundamental one of pecuniary profit. Certainly it would be the least exceptionable one from an esthetic point of view, since the noise would be reduced to a minimum, and it would be rather an ornament to the city than otherwise. That it would be enormously profitable hardly admits of doubt, for it would immediately attract a large proportion of the present elevated traffic, while the cost properly chargeable to the railway itself (excluding rentable property purchased) would be much smaller than might be supposed.

Until some such plan as this has been thoroughly considered we certainly hope no underground road will ever be built in New York. Besides being enormously expensive they are for many reasons uncomfortable and unpleasant to travel in.

Some Poor English Bridges.

It will be remembered that in our issue of May 28 we quoted some very broad claims made by *The Engineer* of London in defence of its rather cheap attempt to prejudice the intelligent British colonist against American bridges and bridge engineers on the strength of the Bussey bridge disaster. Our contemporary claimed in an unequivocal way that the Tay bridge disaster "was the only iron bridge of any dimensions which has ever given way causing loss of life in Great Britain."

We chanced to be able to quote in the same article the fall of one English bridge which had "dimensions," causing the death of one man, because this happened just at the time the Tay bridge was being investigated, but life was too short to attempt any further search, especially as such wretched attempts to impeach a whole people for the faults of single men were little to our taste. Nevertheless, "by others faults wise men correct their own." It is always profitable to know what has been done and is done in other countries, and we may add likewise, that it is always well to puncture inflated claims of any kind which have no foundation in fact. The question of whether these particular claims were such, or not, indeed, may turn upon the question of what are "dimensions," for we are quite ready to admit that neither in Great Britain or in any other country did any bridge disaster ever approach in "dimensions" that of the Tay bridge, but the true intent of the claim (and in fact the exact claim) was that English bridge practice was safe and American was not, so that the trusting colonist would be safe with the one and not with the other.

In respect to this question a correspondent has been good enough to do for us what we were indisposed to do for ourselves, hunt up the following records which are in addition to that previously mentioned by us, and perhaps many others, but which are instructive as showing what has been already asserted in ENGINEERING NEWS, namely that poor American bridges have been as a rule the work of inexperienced men or those of no recognized standing as bridge builders, while poor English bridges are to a very large extent designed by men of high standing in the profession, as was the case with the Tay bridge.

On Jan. 27, 1872, a bridge near Castle Ashby on the Northampton branch of the Midland Railway, gave way under a freight train, injuring the guard. No further particulars are given.

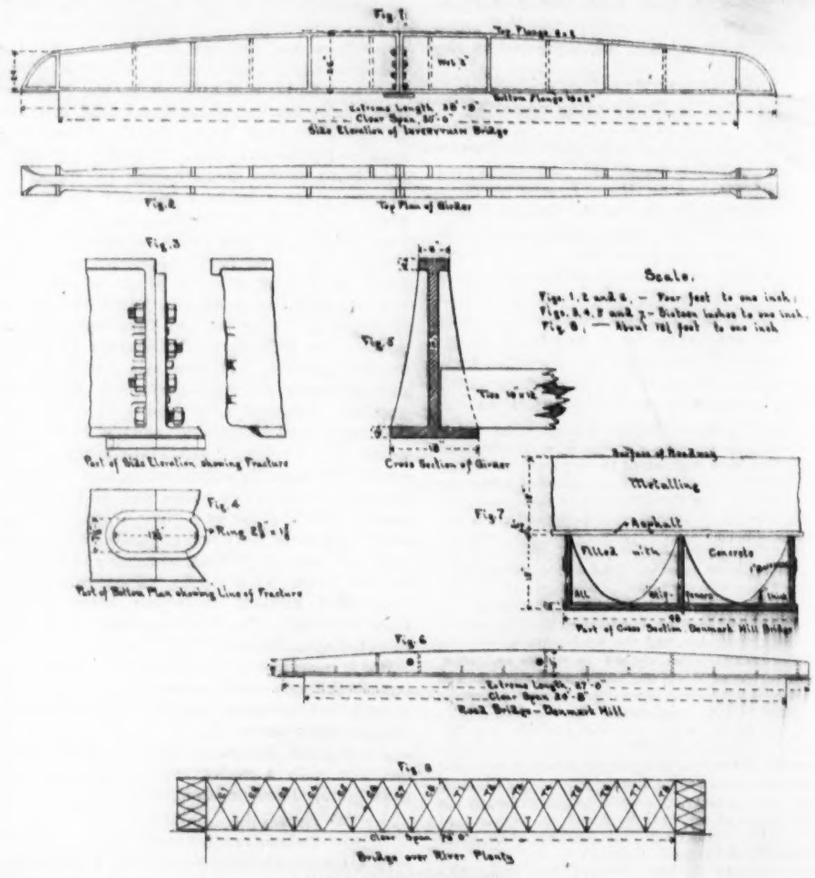
April 7, 1875, a freight train on the North British Railway was crossing very slowly a double track bridge over the Wigtown road near Carlisle, when the structure broke down, precipitating the engine and two cars into the road below and injuring the driver. The bridge was a cast-iron arch of 25 ft. clear span and 17 in. rise at the center. There were five arches or girders, two outside ones, one between the tracks and one in the center of each track. One of the outside girders broke first, and at the break (near the center of the girder) there was discovered "a large flaw which had about half the sectional area of the lower flange." The Board of Trade inspector reported:

"Independently of the flaw in the lower flange of the outside girder, the girder was far too weak for the load it had to carry. Its breaking weight at the center did not exceed 23 tons, whereas to allow for a proper margin of safety, it ought to have been at least double that amount."

We need not be surprised at the light proportions of the girder, when we learn that the bridge *was built in* 1826, and had never been strengthened since. The company which permitted the existence of such a state of affairs operates 1,500 miles of road, and carries every year 22,000,000 passengers, or about one-half more than the New York Central. Imagine the Central or any other American road using a bridge, and a cast-iron one at that, built for the traffic of 1826!

It will be noted that the inspector, who was Maj. Gen. (then Lt. Col.) HUTCHINSON of the Royal Engineers, estimates that the girder was weakened one-half by the flaw in the casting, and that independently of the flaw the girder ought to have been twice as strong as it was. In other words, he regards as safe for use a cast-iron girder four times as strong as another one, which has actually broken down under an ordinary load. In England, this might be considered a sufficient margin for safety, but it would not be thought so in this country.

Nov. 27, 1882, a bridge over a road at Inverythan on the Great North of Scotland railway broke down under a mixed train, killing four persons and injuring fourteen more. This bridge was a cast-iron plate girder structure, clear span 35 ft., extreme length 38 ft. 9 in., height 3 ft. at center and 2 ft. near ends. Figs. 1 and 2 show elevation and plan of one of the girders. The web plate was 2 in. thick, the top flange 6 in. x 2 in. and the bottom flange 18 in. x 2 in. Stiffening ribs were cast on the girders at short intervals. Each girder was made in two halves and united at the center by eight 1¼ in. bolts through projecting flanges, and by a wrought-iron ring, 2½ in. x 1½ in. in size,



Some Poor English Bridges.

shrunk on an oval boss on the under side of the bottom flange (Figs. 3 and 4). This boss was 17½ in. long by 7½ in. wide and one half of it was cast on each half girder. The rails were supported by longitudinal wooden stringers, 12 x 3 in. under one rail and 12 x 4½ in. under the other, one rail being elevated on account of curve in track. The stringers were carried by 10 x 12 in. cross ties spaced about 3 ft. apart and resting on the inside legs of the bottom flanges of the girders (Fig. 5). Between the ties were fitted 4 x 8 in. plank blocked up under the ends to bring their upper surface flush with the tops of the ties and make a tight floor. The two girders were tied together at the ends and two intermediate points by transverse rods 1 1/16 in. diameter, between the cross ties. One of the girders broke near the center as shown in Figs 3. and 4, while the other remained intact. The fracture started at the junction of the boss with the bottom flange, went through that flange and thence through the web nearly to the top flange. On examining

the fracture a large "blow hole" was discovered measuring 3½ in. across the face by 6 in. in depth, extending down into the boss and estimated to reduce the sectional area of the bottom flange from 36 sq. in. to 28 sq. in. The bridge had been in use for twenty-five years.

The investigation into this accident developed the (to Americans) astounding fact that these were at that time in use on this road 313 more spans of cast iron plate girder bridges exclusive of arches, that 91 of them were more than 25 ft. long, and that EIGHT of these were spliced at the center like the one which fell. The number of such bridges on other roads was not known but the inspector stated that it "must be very large."

In the report on this accident the Board of Trade's inspector, Maj. F. A. MARINDIN, entered a rather mild protest against the use of cast-iron for such bridges. He especially recommended wrought iron for a lot of bridges on a new line then being built by the company and for which it was intended that cast-iron be used. Whether or not this recommendation was acted upon does not appear.

Another edifying example of British construction is found in a bridge carrying a street over the tracks of the London, Brighton & South Coast Railway near Denmark Hill station. This bridge had a clear span of 24 ft. 8 in. and consisted of thirteen cast-iron, trough-shaped girders, 27 ft. long, placed side by side, close together and running parallel to the street. Each girder consisted of a plate 48 in. wide and three vertical ribs with curved tops, forming a double trough 15 in. deep at the center and 9 in. at the ends. The bottom and ribs were all 1 in. thick. The ribs were stiffened by ½ in. diaphragms and each girder was attached to its neighbors by three small bolts. Figs. 6 and 7 show one of these girders in elevation and section. To form the roadway, the troughs were leveled up to the tops of the ribs with concrete, on which was spread a layer of asphalt ¾ in. thick, and on this again 15 in. of metalling, forming the wearing surface of the road.

The bridge was built at the time the railway was constructed 1853-5—under the direction of the company's then engineer, Mr. ROBERT JACOMB HOOD, M. Inst. C. E. In December, 1883, it was noticed that the roadway was sinking and upon examining the girders underneath six out of the thirteen were badly cracked and threatening to fail. These were replaced by sound ones. On the night of May 28, 1884, four of the girders suddenly broke and let a portion of the roadway down on the tracks below. No one was on the bridge at the time.

It would probably be difficult to find a parallel to this bridge in America, even among the notoriously flimsy structures built by some "highway men." Certainly no American engineer of any repute would father such a thing. In America, it must be confessed, such pains would hardly be taken to secure a smooth and enduring road surface. The concrete, asphalt and metalling would very likely be represented in an American bridge by a layer of 3-in. planks. But instead of wretched cast-iron troughs an American roadway would be supported by wrought-iron rolled or built beams. The American bridge would be safer if less handsome.

It is curious to note the kind of figuring which is done on some of these bridges. After this accident the company's engineer, Mr. FREDERICK GALE BANNISTER, estimated that the center breaking load and one of these girders would be 60 tons (134,400 lbs.) and that the actual distributed load was 33,775 lbs. equivalent to a center load of 16,888 lbs. These estimates seem to have been about equally far from the truth, for when the experiment was actually tried on one of the sound girders it broke under a center load of 51,727 lbs. In America an engineer would have to figure closer than this or look to some other field of usefulness for a living.

But for real genuine imbecility in bridge building perhaps Australia furnishes more examples than any other part of the world. In its issue of May 15, 1886, ENGINEERING NEWS gave a diagram and description of the Queanbeyan Bridge in that country. This is a highway bridge which is liable to fall at any time with a moderate load. If a crowd should get on it it, would certainly go down. It was built after designs by one of the oldest, best paid and most influential engineers of Australia, Mr. W. C. BENNETT, M. Inst. C. E.

Another Australian highway bridge of curious design is that over the river Plenty, an outline diagram of which is shown in Fig. 8. Aside from the elaborate and ridiculous end posts, so dear to the British heart, the most starting feature is that in the truss there are two systems of triangulation, *but the floor beams are so disposed that only one system can by any possibility support any of the floor or load thereon*, though the two systems are of equal strength! All the compression members are composed of two angle irons latticed. In the members marked C 1 to C 4 in. these angles are 4 x 3 x ½ in. C 5, C 6 and C 7 are 3 x 3 x ½ in. and C 8 is 2½ x 2½ x ⅜ in. The tension members each consist of a pair of flat bars. For T 1, T 2 and T 3 the size 3 x ½ in, for T 4 and T 5, 3½ x ½ in. for T 6 and T 7, 4 x ½ in. and for T 8, 4½ x ½ in. This truss reminds one of the "Parker" truss in the late lamented Bussey bridge, but there is this difference between the two c ses. The "Parker" truss when first built was loaded equally on both systems of triangulation and when re-erected the load was entirely taken off from one system of the old truss and all placed on every other panel point on the other. But the Australian bridge was originally designed as it now stands and, it is difficult to account for the extra system of bracing except on the theory that the builder did not know any better. It was designed by Mr. W. W. WARDELL, M. Inst, C. E.

More examples of this sort of engineering are mentioned in ENGINEERING NEWS of March 27, 1886. Australia is said to be full of them. They have been written up and their shortcomings exposed time and again, but it does no good. The builders are men of high position, possessing the full confidence of the government and paid fat salaries for building just such truck. Any criticism of their work is treated with lofty contempt, and ordinary people who do not understand technical points very naturally, look on their critics as cranks. As Sir JOSEPH PORTER says, "Official utterances are generally considered unanswerable." In this free country, where any man may try his hand at bridge building, if he can get any one else to pay for and take the risk of using his work, we may expect to find occasional abortions, but where bridges are designed by trained experts especially selected by the government for this express purpose we ought to look for better things.

The conclusion of the whole matter seems to be that blundering incompetency is of no nationality, and we should never think of claiming more, to the prejudice of the work of any nation or people, but we cannot but think that under the conditions which exist, it is easier for blundering incompetency to get to the top of the ladder and stay there in England and its colonies than here.

Cable Engines.—A pair of powerful engines for the Chicago Cable Railway Co. have been built by J. Wheelock, Worcester, Mass.

CORRESPONDENCE.

Elevated Railways of the Future.

ALBANY, N. Y., June 8, 1887.

EDITOR ENGINEERING NEWS:

Referring to your editorial opinion in ENGINEERING NEWS of June 4, that the best kind of an elevated road for Broadway is one which does not touch Broadway, permit me to suggest a modification of your plan, which is otherwise exactly what I have long contended to be the only proper kind of elevated structure for future use in New York.

You are right in holding that no more elevated work ought to be allowed in the streets. It was perhaps right to grant a right of way through the streets to the first elevated roads by way of encouraging an undertaking altogether experimental and the result of which no one could foresee. But now that elevated traffic has proven so well adapted to the wants of the people and so exceedingly profitable to the companies engaged in it on the one hand, and so detrimental to adjoining property on the other, no more such construction ought to be allowed in the streets. Future roads can and should purchase a right of way through the blocks, as you suggest, in order to be as far as possible out of sight and hearing from the streets.

Instead, however, of having a stone ballasted road elevated from 20 to 50 ft. above the ground, I would have the tracks 60 to 100 ft. above the street level, so as to clear entirely all ordinary buildings. My elevated superstructure would consist generally of long span iron bridges resting on iron or masonry piers set in the middle of the blocks back of the buildings. In the upper part of New York the blocks are from 160 to 212 ft. long and the streets generally 60 ft. wide, so that to reach from center to center of the blocks would require spans from 220 to 272 ft. long. Where the streets are wider than 60 ft., I would have two piers to a block, but the street and the buildings facing thereon would always be covered by a single span, which would seldom require to be more than 300 ft. long. In the lower part of town, where the blocks are longer in a north and south direction, two and possibly three piers in a block would be required.

Wherever a station is required, I would erect a building of such strength and dimensions as to answer for commercial purposes and at the same time serve as a support for the adjacent bridge spans. The station would be on the top of this building on a level with the tracks, and passengers would be carried up and down by two elevators, the lower entrance to which would be from the sidewalk.

My superstructure would be built for four tracks, two along the lower chord for local trains and two more above for through or express trains. Stations where express trains stop would be two stories high. My bridges would be made strong enough to bear any trains, and by making connection at the Harlem river any road entering the city might have a depot wherever it chose in town.

I would have a tight floor on my bridges and the lower tracks would be protected by riveted lattice trusses on the sides while the upper tracks would have stout parapets, so that even if a train should get off and away from the track in spite of all precautions (which of course would be provided) there would be no danger of its falling down or knocking down a span. I would also have a water main along the bridge with hose attachments at convenient intervals for use in case of fire in any of the buildings below which might endanger the superstructure.

I believe this plan offers the maximum of convenience with the minimum of interference with buildings and streets as well as the minimum of cost, if the right of way has to be purchased. The expense of acquiring and preparing the right of way for such a road would be much less than if the road were on a lower level because most of the buildings underneath would be absolutely untouched. The road would be popular, for the reason that there would be no stairs to climb while the noise of passing trains would be comparatively insignificant at such a height.

Between such a road and an underground one there should be little hesitation about a choice. The cost of the elevated road would be a great deal less, and consequently it could afford to carry passengers for less fare. And as to the comparative comfort of

travel between the two, any one can judge for himself by taking a trip on one of the present elevated roads and then through the Fourth Avenue tunnel.

STRANGER.

[We have referred to this communication in another column.—ED. ENG. NEWS.]

A Correction.

ANN ARBOR, Mich., June 13, 1887.

EDITOR ENGINEERING NEWS:

In your recent publication of my articles on "The New Method of Dimensioning," there are one or two slight errors which need correcting. In Article I, p. 310, the printer has given LAUNHARDT'S formula as:

$$a = u\left(1 - \frac{t-u}{u}\,\frac{min.\ B}{max.\ B}\right)$$

whereas the formula should be:

$$a = u\left(1 + \frac{t-u}{u}\,\frac{min.\ B}{max.\ B}\right) \qquad (1)$$

In the same article he has given the formula of WEYRAUCH as:

$$u = a\left(1 + \frac{u-s}{u}\,\frac{max.\ B}{max.\ B}\right)$$

whereas it should be

$$a = u\left(1 - \frac{u-s}{u}\,\frac{max.\ B}{max.\ B}\right) \qquad (2)$$

On diagram III, p. 376, you have written an explanation of the various inclined lines. The upper inclined line in that diagram should have been marked "Steel riveted girders and rolled beams," and the lower inclined line "W. I., riveted stringers."

A. D. OTTEWELL.

Royal Trans-African Railway.

St. Paul de Loanda, South West Africa,
March 12, 1887.

EDITOR ENGINEERING NEWS:

I have the honor to furnish you with the following information concerning this railroad:—

It will begin at the seaport of Loanda, in the colonial province of Angola, and run across the Continent to the Indian Ocean. The first grand section of this enormous trunk line, now contracted for and under construction, terminates at Ambacca, a coffee district, about 300 kilometres inland. It is located with a maximum grade of 15 per cent. and curvatures of 191 metres radius. The gauge to be one metre. No great engineering difficulties are encountered in this first section, but plenty of raiding man-eating savages. The working staff is as follows: Col. D. E. DAVENPORT, of London, is General Manager; K. P. CRANDALL, of Ithaca, N. Y., Chief Engineer, and GEO. A. SCHELE, of Birmingham, Ala., Chief Assistant Engineer.

Respectfully, L. L.

June Meeting of the American Society of Mechanical Engineers held in Washington, D. C.

The managers of this Convention had wisely waited for the various events of importance in the National Capitol to be concluded, before they convened the august and intellectual body known as the Mechanical Engineers in the City of Washington.

Accordingly, the date was somewhat later than usual, for that body of do-nothing and think less, called Congress, had held an unusually protracted session, because in all probability they found the weather in Washington better suited to mint juleps than the temperature of any other place in the United States. Then came the National Drill with its sequences of protests and dissatisfaction from some who did not get the prizes; after the Washingtonians had a short breathing, came the Mechanical Engineers and the Convention of Doctors. The one discussed "Helical Seams in Boiler-making" and the other "Seams in the Human Body." The one had "A Direct Acting Veener Cutter," and the other, "A Machine for Trimming a Man to the average Size."—Both approach each other on "A problem in Profit Sharing," the difference being that the Mechanical Engineer divides by a fair sized quantity, but the doctor always divide by one.

There is another difference, the earth supports the failures of the Mechanical Engineer, but hides those of the doctor. However, this is a dangerous topic for discussion and one not laid down among those to be considered by the Mechanical Engineer. To follow it too far might lead one of the doctors towards the solution of one of the subjects offered the Mechanical Engineers for discussion, making a direct application of the "Comparative Value of the different kinds of Belting" to the body of the writer. No disrespect to the doctors is intended, far from it; the writer has such respect for a doctor that he has for many years contemplated him from a distance, and wouldn't come nearer lest he lose this respect.

But as to the Convention, it convened and listened to an address of welcome from Mr. WEBB, President of the Board of Commissioners of the District of Columbia. He thought, evidently, that Mechanical Engineering was a most delightful science and that the lot of the engineer *was* a happy one. It might be noted the speaker had never been an engineer. He stated, in conclusion, our reward would be the benedictions of mankind. This sounded well, but this benediction business is getting to be something of a "chestnut." The trouble is, that one can't pass it in the market, and it is doubtful, but not *very* doubtful, whether we could have traded benedictions with the proprietor of Willard's hotel for our board bill. The President (of the Society not of the United States), Mr. BABCOCK, responded to this address, and did it well, but then that was what we expected, and thus far have never been disappointed.

The report of the Committee on "Uniform Tests" followed. They were at work, something unusual by the way for most committees; and further they would soon have the matter in shape for making a report. The nature of the replies, although blanks were specially provided for the purpose were so varied as to prevent immediate classification. It is astonishing how many blunders intelligent men will make in filling in a blank. The writer is a sample, certainly, of the blunder, having carefully written the name of his father in a column provided for the name of his eldest lineal male descendant, as his successor in the Loyal Legion.

The Committee on "Standard Pipe Threads" reported, and the gist of it was that pipe not covered by the Briggs formula and tables was of rather a local nature, and they hardly thought it came within their province. This committee had previously reported in favor of the Briggs standard, and the report above was of a supplementary character.

The Council then acknowledged in a public manner the generosity of Mr. S. W. BALDWIN, who had purchased and presented to the Society the apparatus owned by the late Mr. HOADLEY. It was also stated that nearly $1,000 was at the credit side of the Library fund and that the membership was about 800.

An invitation was received from JOHN D. FORD principal of the Manual Labor School at Baltimore, Md., inviting the Society to inspect its operations, also one from JOHN W. WESTON, Commissioner General for the United States to the Paris International Exposition of Railway Appliances. Mr. WESTON asked the Society to co-operate in making this exhibit a success. It is to be hoped that this letter may meet with a cordial reception at the hands of the members generally, for if there is one profession in which the United States is most preeminent, as compared with other nations, it is this very profession of Mechanical Engineering. It would seem therefore that our exhibit in that line should be to some extent commensurate with our abilities.

The Secretary having announced in his circular that the early lunch at Willard's hotel was a "great convenience," the Society proceeded to prove the truth of his remarks, for Nature by this time had turned the "convenience" into an absolute necessity, and the members in general found themselves, as this Society was a short time previous, provided with a hollow-way, the difference being ours was present, but that of the Society was President.

The Corcoran Gallery attracted the members that afternoon, and is too familiar to your readers to require description. The collection has received several additions of late, prominent among which are Renouf's "Helping Hand" and Church's "Niagara."

That evening various subjects were treated by the "shining lights" of the profession as follows:

"Tests of Comparative Value of Different Kinds of Belting," by SAMUEL WEBBER. The paper was descriptive of the apparatus used and the results obtained from experiments. The writer's determination to "test every belt as it is put in the market without oiling," shows that no belts for public service were to be tested, no aldermanic belts for instance, for the "youngest child" and the "oldest inhabitant" know that such belts, or rather the contracts for them, must be thoroughly "oiled" or they will "slip." The conclusions of Mr. WEBBER were as follows: The leather-lined canvass belt transmitted more power without injury to itself than any other. The five-ply belt of this kind showed a higher coefficient of effect with a strain of 76 lbs. to the inch than with one of 117, and that the four-ply cotton and leather belt, the Hoyt belt and that of Schultz, showed a higher coefficient with 62½ lbs. per inch than with 83⅓. The link belt he characterized as wrong in principle and defective in operation. The wooden and paper pullies he found to have superior holding capacities. Following this paper came one by L. H. RUTHERFORD, entitled, "Should a Piston Packing Ring be of the same Thickness at every Point." The paper bristled with Greek letters and integral signs, together with a fair assortment of sub-accents and radical signs, but a careful perusal by the writer failed to find the answer. The paper seemed rather to be a theoretical discussion with a view to get up a discussion on the practical side. The writer can truly say, like the Army Chaplain, who was bothered by the soldiers with question as to when the next mail would come in, that: "he does not know" whether it should be of the same thickness or not, and he would almost like to add what the irreverent soldier painted on the Chaplain's tent "Neither does he care a ——."

"The Systematic Testing of Turbine Water Wheels in the United States," by Prof. THURSTON, was an elaborate and interesting account of the tests made at Lowell and Holyoke, and also chronicled the first test made in the United States in 1843 by Mr. ELWOOD MORRIS, of Philadelphia. He showed that the Holyoke testing flume reduced the error to less than 1 per cent., and probably were so nearly accurate that for practical purposes they might be considered as exact. He thought these tests had stimulated a more perfect construction of turbine, and that each large manufacturer would eventually have a private testing flume. Prof. THURSTON next presented a paper on "Helical Seams in Boiler Making." This was a short summary of the benefits of such seams as weighed against other considerations.

He thought that in some cases there was a gain of strength in the longitudinal seams at the expense of the girth seams. He thought this form of seam was very wasteful of metal, if so much inclined as to secure any considerable gain of strength; but this objection did not hold if the boiler or flue was built of a succession of ring courses laid side by side, or in such constructions as Root's spiral pipe, where the courses are helical.

Mr. JOHN T. HAWKINS read a paper on "The Education of Intuition in Machine Designing." This was rather an attempt to find a middle ground between the theoretical engineer, on the one hand, and the thoroughly practical man on the other. He decried "Rule of Thumb" as a thing to be relied on exclusively, but believed by education a "Rule of Thumb" method would tend to tone down the fine spun theories of exclusively scientific analysts. He thought this view had not received the attention it should in technical schools. If Mr. HAWKINS will visit the Institute of Technology in Boston, he will find there a persistent effort to harmonize the two views, and one attended with a remarkable degree of success.

Mr. CHAS. E. EMERY presented "Notes for Discussion on Cylinder Condensation and the Reduction of the same by the use of the Compound Engine," and also "Notes for Discussion in Relation to the Development of the Compound Engine and the probable limit of Steam Pressure in Marine Engines and Boilers." These papers elicited a lively discussion, and honors seemed pretty evenly balanced between Mr. EMERY and those differing from his views. After this Mr. EMERY presented a paper entitled "The Comparative Value of Steam and Hot Water for transmitting Heat and Power," and naturally enough he proved

steam to give the better results. If he could'nt do this he would hardly be the man to represent, as he so well does, the New York Steam Heating Co. He proved his case by figures, and this also provoked some discussion, some members trying to disprove the figures.

ALBERT STEARNS then described a novel evaporating pan in his paper entitled "Evaporation by Exhaust Steam," and this closed the evening.

The next day the Society visited the Bureau of Printing and Engraving, and saw how the government makes money. They also saw how careful the government is that no one else shall profit by their manufactures. Each machine, as it prints, registers the number, and before leaving the building every employé must present a receipt showing that he or she has delivered the number of sheets called for by the machine. In case of a spoiled sheet it has to be accounted for like a perfect one. A registering machine attracted considerable attention by its peculiar mechanical action, but we had to gaze on it from afar, no one being allowed to go behind a certain iron railing. Our imaginations being excellent we have no doubt the machine is a great success, indeed we are sure of it, for our cash, what little we have, has never been refused by any Washington invigorator, and if they don't know a good bill, living on the spot, what could be expected of any outsider. This proves that the numbers which change for each revolution, change correctly.

(TO BE CONTINUED).

PERSONAL.

Col. HORACE G. SCOTT has been elected President of the Southern Ohio R. R. Co.

HENRY G. DENNIS will be Engineer in Charge of the water-works at Waterville, Me.

PARKER SPOFFORD, Bucksport, Me., is Chief Engineer of the proposed Castine & Bangor R. R.

FREDERIC DANFORTH, C. E., of Gardiner, Me., will be Engineer in Charge of the Dover and Foxcroft water- works.

HENRY W. ROGERS, formerly Superintendent of the water-works at Lawrence, Mass., has been appointed Superintendent for the Gardiner Water-Works Co., Gardiner, Me.

H. T. RICHARDS, formerly Roadmaster of the Sonora R. R., has been appointed General Manager of the New Mexico & Arizona and Sonora railroad companies. He will succeed J. H. SCOTT, who has been appointed Superintendent of the Atlantic & Pacific R. R.

E. A. SMITH, Roadmaster of the Boston & Maine R. R., has been with the company for 50 years. He went on the road when it was only 8 miles long, from Andover to Wilmington, and the company owned only 1 engine and 2 cars.

FRANCIS R. SHUNK, the son of the well-known civil engineer, WM. F. SHUNK, and the grandson of FRANCIS R. SHUNK, one time Governor of Pennsylvania, graduated No. 1 in a class of 64 members at the West Point Military Academy last week.

LUIS P. CILLEY, a student in the Civil Engineering Department of the Maine State College, has taken a position as leveler on the Somerset R. R.; E. D. GRAVES, a former graduate of the college is transitman on the same road. A. H. WHITE, of the sophomore class, has accepted a position on the Canadian Pacific Ry.

C. B. COLE has been appointed Superintendent of the Cascade division of the Northern Pacific R. R., to succeed O. SPRAGUE, resigned; his headquarters will be at Tacoma, Wash. Ter. C. S. PROWELL has been appointed Assistant Superintendent of the division, with headquarters at Ellensburg, Wash. Ter.

The following are the names of the staff on the construction of the Canadian Pacific Railway Co's line in Maine. Chief Engineer, A. L. HOGG, of Montreal, headquarters at Greenville, Me.; Manager of Construction, JAMES ROSS, of Montreal; Division Engineers, JAMES A. PATTISON (Moose River division), headquarters at Moose River: S. B. MCKEE (Greenville division), Greenville, Me.; MATHEW NEILSON (Brownville division); ALEXANDER MIDDLETON (Mattawamkeag division).

CHANGES OF ADDRESS, MEMBERS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS.

C. M. CRAIG (Care J. W. Woolfolk) Montgomery, Ala.

R. MORLEY HARRISON, 99 Douglas street, Glasgow, Scotland.

D. JONES LUCAS, 106 East 23d street, New York City.

Maj. HENRY G. PROUT, Editor *Railroad Gazette*, 73 Broadway, New York City.

H. T. RICHARDS, Assistant General Manager, Sonora R. R., Guaymas, Sonora, Mexico.

F. M. RUTHERFORD, Assistant Engineer and Roadmaster, Anniston & Atlantic R. R., Anniston, Ala.

JOHN S. SCHAEFFER, Globe Building, Room 85, Newark, N. J.

ROBERT SOMERVILLE (Somerville & Johnson), Greenville, Miss.

SOCIETY PROCEEDINGS.

American Society of Civil Engineers.—List of new papers to be read at the coming Convention at Hotel Kaaterskill, July 2, 1887.

"The Disposal of Sewage, CHARLES A. ALLEN, C. E. "The Disposal of Sewage in Massachusetts," FREDERIC P. STEARNS, C. E. "Cable Railway Propulsion on New York and Brooklyn Bridge, and 10th avenue, and 125th street," WILLIAM H. PAINE, C.E., and G. LEVERICH, C.E "The Poughkeepsie Bridge," JOHN F. O'ROURKE, C. E. "The Kentucky and Indiana Bridge," MACK MOULTON, C. E. "Some Experiments on the Strength of Bessemer Steel Bridge Compression Members," JAMES G. DAGRON, C. E. "Memorandum as to the Form of Rails and Wheels," A. M. WELLINGTON, C. E. "Stresses in Bridges," W. H. BOOTH, C. E.

At the semi-monthly meeting, on June 15, the regular programme, which was to read several discussions of various papers, was interrupted to listen to an informal report of the condition of the work on the Panama Canal, by M. J. BOULANGE, one of the Chief Engineers under the General Manager, and one of the engineers of oldest standing on the Isthmus, he having been there over three years, but recently compelled to leave from bad health.

M. BOULANGE'S account was exceedingly discouraging from every point of view, and in some respects amazing. The vital question of controlling the Chagres river, has as yet not even been definitely studied by survey. The first work in that direction was begun six weeks ago. The constant shifting of engineers has had much to do with this, but on all parts of the canal it is the same. There are no definite plans, surveys or profiles, and vague pencil sketches are all the new engineers are likely to get. From 1879 until now, about 30,000,000 cu. m. in all have been done, out of an estimated total of 140,000,000, but this estimate is little better than a guess, as no exact estimates have been made. To accomplish this much $180,000,000 have been spent, M. LESSEPS corrected estimates having been that $240,000,000 would finish the canal. It hardly appears probable that work can continue more than 3 or 4 months longer before the present funds will be exhausted, and then there appears no possibility but that the work will have to be definitely suspended and abandoned. Very great damage to the executed works was being done by water, while it rains almost constantly night and day, for nearly nine months of the year. The difficulty of getting men is very great. He had been sent to the Bahamas to get them, and after four months exertion succeeded in taking back 6 men. As illustrating the dangers of the climate, out of 72 engineers and assistants who came out a year ago only 11 were left, and about 45 of this number were dead, but he had been fortunate in withstanding the climate. (President WORTHEN suggested that this was an excellent place for assisted emigration.) Some 10 miles of the canal was nominally complete. The great Culebra cut was about one-eighth down, and one-seventh the proper width. An experiment had just begun with 800 Chinamen, but it was not yet determined whether it would succeed. After great exertions 171 men had been brought from Africa, who were practically impressed, but the mortality was frightful. Moreover, much of the work done would have to be abandoned if the work was ever completed, because in the wrong place. It was the poor people of France who had furnished most of the money, and the crash which seemed inevitable would be a very serious matter to them. The contract prices were equivalent to about 80 cts. per cubic yard for earth, $1.10 for mixed earth and loose rock, $1.40 for rock more than 100 ft. above sea level, $1.85 for rock below this and above sea level, and higher prices not given out for the 30 ft. of excavation below sea level.

The picture of the condition of things was unrelieved by a single hopeful feature, yet corresponds closely with other reports given in this, and other issues.

Engineers' Club of Kansas City.—Regular meeting held June 6 in Club Room, Mr. OCTAVE CHANUTE in the chair. 13 members and 2 visitors present. The following were elected as:

Member, G. P. N. SADLER, Leavenworth, Kan.; Associate Members, C. A. BUETON, Kansas City Cable Railway Co., C. G. WADE, Kansas City Cable Railway Co.

A letter of resignation from G. R. BANCUS was read and accepted. A letter from Mr. J. C. EISENMANN was read soliciting co-operation with the council of engineering societies.

Mr. WADDELL presented for Mr. J. C. TRAUTWINE a copy of the last edition of Trautwine's "Pocket Book." On motion of Mr. WADDELL it was voted to devote the next regular meeting to a discussion of the 24-Hour System.

The paper of the evening was then read by Mr. A. J. MASON on "Railroad Engineering in Australia." The natural characteristic features of the country and their influence, as well as that of the government, on the location and construction of railroads, was dwelt upon, and the opening for American engineers, contractors, and methods of work suggested. The paper was well discussed by those present.

KENNATH ALLEN, Sec'y.

The Connecticut Engineers.

The members of the Connecticut Association of Civil Engineers and Surveyors met at Norwich on the 7th of this month, at the office of the President, C. E. CHANDLER. Meetings for the transaction of business were held at 2.30 and 7 P. M. At the former the following were elected members:

Massachusetts: R. C. P. COGGESHALL, and A. B. DRAKE, of New Bedford, and L. A. TAYLOR, of Worcester.

Connecticut: C. H. TRUESDELL, Central Village, JOEL W. WHEELER, Ansonia, J. E. DUTTON, Niantic, C. V. PENDLETON, Yantic, and EDGAR CLARK, Putnam.

HENRY T. POTTER, of Norwich Town, and ROBERT R. SMITH, of Hartford were unanimously elected honorary members.

A number of excellent blue-prints were distributed in accordance with a rule which the Association is endeavoring to establish. Each member is asked to prepare a number of prints of uniform size illustrating some interesting piece of engineering. By exchanging these at the meeting he should receive as many *different* prints as he brought ones of the same kind.

At the evening sitting a paper on "The Relation of Photography to Engineering" was read by W. H. BURNETT, of Norwich, showing the use of photography in reducing and enlarging maps, and in recording evidence of the progress and mode of construction of important structures. This was followed by the reading of notes in regard to some of the principal works visited during the day.

The greater part of the time was spent in driving along the beautiful roads that surround Norwich, to visit the places most interesting to engineers.

In the morning the City Engineer and Street Commissioner showed the arrangement of the Greenville sewers. HIRAM COOK, Prest. of the Norwich Water Power Co., took the party to see the new Greenville dam, built to replace the one swept away by the spring freshet of 1886.

The interesting machinery in the buildings of the Norwich Bleaching, Dyeing and Printing Co., was inspected under the guidance of E. P. GARDNER, engineer for the company.

In the afternoon, the Mayor, the members of the Board of Water Commissioners, and J. A. BRAND, Superintendent of Water-Works, joined the engineers, and another excursion was made to see Norwich Falls and dam on the Yantic river; the city reservoir; the Ponemah mills and dam, designed and constructed under the superintendence of H. T. POTTER; the iron railway bridge over the Shetucket; and the tunnel under Laurel Hill on the N. & W. R. R.

American Association for the Advancement of Science.—The thirty-sixth meeting of this Association will be held in New York on Aug. 10—16, 1887. Prof. F. A. BARNARD, President of Columbia College, is the Chairman of the Local Committee, and the Trustees of Columbia College have tendered the halls of college for the meetings. The New York Academy of Science have formed a special committee to co-operate with the Association. The hotel headquarters will be at the Buckingham, Fifth avenue and Fiftieth street; arrangements have also been made whereby board and lodging for members and families may be secured at from $1.50 to $4.00 per day in various hotels and houses within easy reach of the college. For further information and business, address the Permanent Secretary at Salem, Mass., to Aug. 6; after that date to Aug. 17, his address will be Columbia College, New York City.

Sixth Annual Convention of the N. E. Water Works Association.

The sixth annual convention of the New England Water Works Association met at Manchester, N. H., on June 15. The following members reported to the Secretary at the first meeting:

ALBERT S. GLOVER, of West Newton, Mass.; ROBERT C. P. COGGESHALL, New Bedford; WM. R. BILL-

INGS, Taunton; CHARLES K. WALKER, superintendent, ARTHUR E. STEARNS, registrar, Manchester; FRANK E. HALL, Quincy; JAMES H. HATHAWAY, New Bedford; GEO. H. FROST, New York; JONAS M. CLARK, Northampton, Mass.; W. H. RICHARDS, New London, Conn.; CHARLES H. BALDWIN, Boston; EDWIN DARLING, Pawtucket, R. I.; R. M. GOW, Medford; M. M. TIDD, Boston; WM. KENT, Woonsocket, R. I.; W. C. WILCOX, Waltham; A. G. PEASE, Spencer, Mass.; H. C. FRENCH, Kingston, Mass.; J. H. GAMWELL, Palmer, Mass.; S. S. COOLIDGE, Bellows Fall, Vt.; GEO. C. BATCHELDER, JOHN G. BRADY, Worcester; JOHN C. KELLEY, New York.

A large number of applications for membership were received.

At 3 P. M. the Association assembled in the courthouse and the Hon. JOHN HOSLEY, Mayor of Manchester, received them with a short but hearty speech of welcome.

The first paper read was by Mr. EDWIN DARLING, Superintendent of the Pawtucket Water Works, which will be found in full elsewhere in this issue. In the absence of Mr. HENRY W. ROGERS, the president, Mr. WILLARD KENT, Superintendent of the Woonsocket Water Works and vice-president of the Association, presided over the meeting.

PUBLICATIONS RECEIVED.

Proceedings of the Association of Dominion Land Surveyors at its Fourth Annual Meeting held at Ottawa March 8th and 9th 1887. 92 pages, 8 vo. 1 folding plate.

Proceedings of the Association of Provincial Land Surveyors at its Second Annual Meeting held at Toronto, March 1st, 2nd and 3rd, 1887. 135 pages, 8 vo. and 4 folding plates.

Here are two neat pamphlets, which both by their bulk, and interesting contents, attest the earnestness and intelligence of our Canadian brethren, while the promptness with which they have been edited and printed for circulation are calculated to relieve the associations which they represent from any imputation of "slowness" as compared with our American Surveyor's Associations, especially the oldest of them, which manage to issue their Proceedings in time to distribute them at the succeeding annual meeting or thereabouts.

The addresses of Capt. E. DEVILLE, Surveyor General, and GEO. B. KIRKPATRICK, P. L. S. of the Crown Lands Dept. Presidents of the respective Associations are very interesting reading for Land Surveyors and others interested in the development of the Northern portion of this Continent: the papers are all valuable and indicate the high grade of intelligence of the membership. In the smaller pamphlet the papers are: "Micrometer Measurement of Distances:" by WILLIAM OGILVIE, D. L. S.: "A Traverse: Survey" by OTTO J. KLOTZ, D. L. S.: "A Tangent Scale Protractor" illustrated on folding plate by S. L. BRABAZON, D. L. S.: "Directions for Preserving Natural History Specimens:" by Prof. MACOUN, of the Geological Survey of Canada: "Report on Government Map-Making:" "Memorial Setting Forth the Benefit of a Coast and Geodetic Survey of Canada;" in the other pamphlet the papers are: "Crown Surveys" by ELIHU STEWART, P. L. S.: "Solar Azimuths," by JOHN MCAREE, D. T. S.: Paper No. 1 of other pamphlets: "Assessment of Benefits in Drainage Surveys," by WILLIS CHIPMAN, P. L. S. Brockville: "Trussed Beams," by Prof. J. GALBRAITH, Toronto: "Highway Bridges," illustrated very fully with 4 large folding plates, of value to every young bridge engineer, by M. J BUTLER, M. Am. Soc. C. E., Napanee; "Mining in the Port Arthur District," by H. D. SEWALL, Assoc. M. Inst. C. E., Port Arthur: "Electric Lighting of Small Towns," by F. F. MILLER, Asso. M. Inst. C. E. There was a very fine exhibit of instruments, all of which are well described. There are 117 members in this Association and 81 in the other. A. O. WHEELER, of the Department of the Interior, Ottawa, is Secretary-Treasurer of the Dominion Association, and WILLIS CHIPMAN, P. L. S. Brockville, Ont., fills the same office for the Provincial. The publications are cheap at 25 and 50 cents respectively and can be had by addressing the Secretaries. As the editions are probably limited it is well to consider that it is the "early bird, etc. etc."

Secretary CHIPMAN very naively impresses on the members "the advisability of patronizing those who advertise with us," a hint which ought to be remembered by possible advertisers in the next edition.

MR. W. W. SLATER, Superintendent of the block signal system of the Southern Pacific Co., in use on the Oakland mole, is experimenting with incandescent electric lights, to learn if they may be applied to the signals at the switches and on the bridges and poles.

STATISTICS OF NEW WATER-WORKS CONSTRUCTION.

(*Specially Communicated.*)

CONTINUED FROM PAGE 370.

Carlyle, Ill.—The works were commenced in December, 1886, and will be completed about July 1. F. W. RAEDER is the Engineer. The contract was taken by the Water, Light & Power Co., St. Louis. Mo.; the pipe, specials and stand-pipe will be furnished by the Schickle, Harrison & Howard Iron Co., St. Louis, Mo., and the valves and hydrants by the Ludlow Valve Co., Troy, N. Y.: the machinery will consist of Deane pumps, and a Hyatt filter plant will be put in. The stand-pipe will be of steel, 110 ft. high. The franchise is owned by the Carlyle Water, Light & Power Co.; President, J. J. RANDALL; Secretary, F. W. RAEDER. The franchise is for 21 years and the rental is $48.33 per hydrant and $45 on extensions. The present population is estimated at 2,500.

Rochester, Minn.—The works were commenced May 1, 1887, and are to be completed by July 1; they were designed by Moffett, Hodgkins & Clarke, and WM. WALTER is Constructing Engineer. The contractors are Moffett, Hodgkins & Clarke, Watertown, N. Y., and the masonry, foundations, buildings, trenching and pipe-laying have been done by days work; the pumping machinery will be supplied by H. R. Worthington, New York; the pipe and specials (4-in. to 14-in.) by the Warren Foundry & Machine Co., New York, and the stand-pipe (25 ft. by 62 ft.) will be built by Riter & Conley, Pittsburg, Pa. The franchise is owned by the Rochester Water Works Co.; President, J. F. MOFFETT; Secretary, J. V. CLARKE. The franchise calls for 120 hydrants at a rental of $3,900 for 30 years. WM. WALTER is Superintendent of Construction. The present population is estimated at 7,000 to 8,000.

Kingston, Mass.—The works were commenced April 12, 1886, and water was pumped into the mains Aug. 10, 1886; they were designed by A. H. HOWLAND, of Boston, and W. C. BOYCE, of Worcester, Mass., was Constructing Engineer. The masonry, foundations and buildings were done by the Water Commissioners; the contractors were, for pumping machinery, George F. Blake Manufacturing Co., Boston; for pipe and specials, A. H. McNeal, Burlington, N. J.; for trenching and pipe laying, Thos. F. Maney & Co., Boston; for valves and hydrants, Coffin Valve Co., Boston; for well and reservoir, Channing Stranger, Kingston. The following were the prices paid for trenching and pipe laying: 14 cts. for 4-in., 15 cts. for 6-in. and 20 cts. for 8-in. When the reservoir is full it gives a head of 181 ft. above the pump house floor. The franchise is owned by by the town and the works are managed by a Board of Water Commissioners. MELVIN C. FRENCH is Superintendent. The present population is estimated at 1,570.

(TO BE CONTINUED.)

NOTE.—The above statistics of new construction are sent in response to special inquiries sent out by us to contractors, superintendents, engineers and others having to do with new works. We have a special blank for this service, and will be pleased to forward one or more on application. We invite co-operation in this special subject.

CONSTRUCTION NEWS.

Water.

IN the compilation of Statistical Tables of American Water Works, special efforts were made to have them as accurate as possible. Errors have occurred in a few instances which have been brought to our attention, and we especially solicit early information of *any errors* that *any person* may discover, so that they may be corrected. The range of information in future editions will be greatly extended, and we now invite suggestions upon the features most desirable, from water-works officials, engineers, contractors, and parties dealing in machinery and other supplies for water-works. ALL CORRESPONDENCE, ALSO ALL REPORTS, MUST BE ADDRESSED TO ENGINEERING NEWS, TRIBUNE BUILDING, NEW YORK, as future issues will be compiled in this office and under our personal supervision.

Weeping Water, Neb.—No bids have yet been received for the water-works, and the town is waiting for propositions for a franchise. Address J. F. TRAVIS.

York, Neb.—The Strang Co., of Omaha, has a franchise for 25 years. There will be 5 miles of pipe and 50 hydrants for an annual rental of $3,000.

Water-Works in Indiana.—It is stated that about 20 water-works are projected in the State. They range from $50,000 to $400,000 in capital.

Binghamton.—We have received copies of the annual reports of the Board of Water Commissioners for the years 1884, 1885 and 1886 from DARWIN FELTER, Superintendent. The report for 1886 was noted in our issue of May 7, page 306.

The National Water Purifying Co., New York, has orders for plant for the "National" system of filtration for Chattanooga, Tenn., and Champaign, Ill. At the former place a plant of 3,500,000 galls. daily capacity will be put in. J. C. SYMONS is secretary of the company.

Mobile, Ala.—In the suit of the Bienville Water Supply Co. to restrain the Mobile Water Works Co. from laying pipe or supplying water: the court has decided in favor of the latter company, on the ground that the franchise of the former only gives the exclusive right to supply water from Three Mile creek. The Mobile Water-Works Co., in which Samuel R. Bullock & Co., of New York, are interested, which has been proceeding with its works, will now push them to completion.

Old Orchard, Me.—The town has accepted the proposition of Turner, Clark & Rawson, of Boston. The supply will be taken from Phillips spring, and the contractors will lay 6 miles of 10-in. pipe and 25 hydrants. The hydrant rental is to be $1,000 per annum for 20 years and for the supply of public fountains, schools, flushing sewers, etc., the company is to be exempted from taxation for 20 years.

Merritton, Ont.—We have received from THOMAS MONRO, M. Inst. C. E., of Thorold, Ont., a copy of his report made by him, dated October, 1885, on a scheme for a water supply for the village of Merritton, the money for which, $60,000, was voted a few days ago. The report recommends that the supply be taken from the summit level of the new Welland canal, as that point affords the greatest available head, the purest water, a permanent supply, entire non-interference with the working of either canal, and the most suitable position for a settling pond. Under ordinary circumstances the water will be taken from the pond, but in cases of emergency can be taken direct from the canal The distribution mains will be 14, 12, and 10 ins diameter. An alternative scheme is briefly considered, and also the possibility of supplying Thorold by the same system. The estimate is as follows: Settling pond, valve house, culverts, etc., $11,500; 6,000 ft. of 14 in. main, laid complete, part in rock and about 1,300 ft. in heavy trenching, at $2.50, $15,000; 10,000 ft. of 12-in. pipe, laid in trench, at $1.60, $16,000; 4,000 ft. of 10-in. pipe, laid complete, at $1.25, $5,000; hydrants, valves, and special castings, $3,500; superintendence and contingencies, $4,000; total, $55,000.

Electrical Items.—The Pittsfield Electric Illuminating Co., of Pittsfield, Mass., is changing its plant from the old direct current system to the Westinghouse Alternating System. The first installment is for 1,300 lights, and the company has the contract for the city lighting for the ensuing year. 25 candle-power lamps will be used. A line will be run to Lennox, Mass., a distance of six miles, for the purpose of lighting the summer residences in that town.—The town of Bellevue, Pa., is introducing an electric railway operated from 100 horse-power engine, the contract for which has been awarded to the Westinghouse Machine Co.—The Parkersburgh Electric Light Co., Parkersburgh, W. Va., has installed 1,300 lights on the Alternating System the steam plant consisting of two 60 horse-power Westinghouse engines. In adopting the Alternating System, the company was governed largely by the fact that it was able to locate the plant on the outskirts of the town instead of as originally proposed in the center of the business district.—The Hartford Light & Power Co., Hartford, Conn., secured its charter after an especially bitter fight. It is installing the Westinghouse Alternating System, with Westinghouse engines, and is meeting with great success in extending its market.—The Plainfield Electric Light Co., Plainfield, N. J., has nearly completed the enlargement of its station to a capacity of 3,000 lights on the Westinghouse Alternating System. This is said to be the handsomest finished station in the country. The light is exceedingly popular, both for commercial and domestic use, and the financial results to the company are said to be very satisfactory.

Milwaukee, Wis.—G. H. BENZENBERG, City Engineer, has issued his report for 1886. The water mains were extended 13.846 miles, making a total of 133.878 miles. The sewers were extended 10.227 miles, making a total of 137.733 miles; of the new work 20,408 ft. were of brick and 38,385½ ft. of pipe. Of street work 20.884 miles were performed, and 14 miles of sidewalk constructed. The street cleaning and removal of ashes,

done by men and teams employed by the day, cost $43,555.63 and $17,277.89 respectively. Two iron swing bridges, with stone piers and abutments, were constructed, and contracts let for a third (the substructure to C. H. Starke for $21,250, and the superstructure to W. H. Keepers for $10,827). Contracts for dredging were let to C. H. Starke at the following prices: Milwaukee, river, 18 cts. per cu. yd.; Menomonee river, 15½ cts.; Kinnickinnic river, 15 cts. The report contains very full and complete tables of all the city work done, the location, contractors, cost, etc. The water pipe was supplied by the Cincinnati & Newport Iron & Pipe Co., of Newport, Ky.; and was laid by M. Philbin, of Chicago; the river crossing was laid by Thacher & Breymann, of Toledo, O. The total pumpage at the North Point station (3 engines) was 6,525,6.9,311 galls., and at the high service station (2 engines) 608,161,623 galls. Tables of the engine performance are given. The report is accompanied by a large city map showing the water distribution system, indicating the different sizes of pipe, the valves, hydrants, etc. The Public Works Commissioners are G. H. BENZENBERG (President, *ex officio*), C. P. FOOTE, W. P. O'CONNOR, and GEO. P. TRAEUMER; A. H. SCOTT is Assistant City Engineer.

Madison, Wis.—JOHN B. HEIM, Superintendent of the City Water-Works, has sent us copies of his reports for 1883-84, 1885 and 1886. The first annual report is dated October 6, 1883. CHESTER B. DAVIS was Superintendent of Construction. The works were built in 1882. The system is direct pressure, and the supply is pumped from six artesian wells by two high pressure Reynolds-Corliss engines with Knowles pumps; the daily capacity is from 1,200,000 to 2,500,000 galls. The total consumption for the year ending October 1, 1886, was 236,649,850 galls. The population in 1885 was 12,063. Mr. HEIM writes us that there are now 18 miles of mains, and 3 miles are to be added this year; another artesian well is being drilled. From the beginning, the works have paid over and above the operating expenses. The analyses in the reports show the water to be very pure and of excellent quality.

St. Paul Minn.—The Board of Public Works has issued its report for 1886. The contract prices for street improvement were: asphalt paving, including granite curb and grading, $3.26 per sq. yd.; cedar block paving, including granite curb, $1.88 per sq. yd.; pine block paving, including granite curb, $1.68 per sq. yd. Pine block pavement has been laid only on such streets as were believed by the city engineer to have too steep a grade for the safe use of cedar blocks, on account of its slipperiness on steep grades. Of sewers, 11.04 miles have been constructed; 53.8 miles of wood sidewalks and 9 mile of stone sidewalks. Tables are given of the various public improvements carried out, and the engineer's reports describe very fully all the public work. During the year the iron bridge at Robert St. and the the wooden bridges at Arcade St., Western Ave. and Pleasant Ave. have been completed, the Third St. and Decatur & Payne Ave. bridges are under contract; the report the Assistant Engineer describes the present condition of all the city bridges and gives a tabulated description. The report is accompanied by a view of the new Robert street bridge; there are 9 spans, channel span, 352 ft. three of 200 ft., one of 179 ft., one of 150 ft. two of 55 ft. and one of 40 ft. total length 1,540 ft.; the roadway is 32 ft. wide, with two sidewalks 10 ft. wide. It was built by the Morse Bridge Co., Youngstown: O. WILLIAM BARRETT is President of the Board of Public Works. The City Engineer is LEONARD W. RUNDLETT, with Assistant Engineers ALBERT R. STARKEY and GEORGE L. WILSON.

WE have mailed a free copy of Statistical Tables of American Water Works of 1887 to every water-works company, public or private, listed in the Tables: to make sure of their having been received, we notify all those sent to by postal card of our action in the matter, and in a number of cases we have duplicated the sending on account of the first book having been lost in the mails. *If there is a single water-works office in the United States or Canada* where at least one copy of our Statistical Tables cannot be found, we will be obliged for the information. We have also distributed 500 copies among the newspapers of the country and have had nearly as many notices. In a number of cases we have supplied a city council with one or more copies by request, and it may be assumed that the edition has been very thoroughly distributed "where it will do the most good."

New Water Companies.—The Wickford Water Co. and Wakefield Water Co. have been incorporated in Rhode Island.—The Warren Aqueduct Co., Warren, Mass., has elected the following officers: Treasurer, CHARLES H. CORNISH; Directors, JOHN J. LEACH, W. C. GAGE and SILAS HOBBS.—The Green Island Water Co. has been incorporated at Green Island, N. Y., by JOHN H. MOFFETT, HENRY C. HODGKINS, JOHN V. CLARKE, CHARLES T. MOFFETT, ROMEYN FREEMAN, FRANK WATTS, and CLARENCE A. HOUSE, all of Watertown, N. Y. Capital stock, $60,000.—The Holmesburg Water Co. has been incorporated at Harrisburg, Pa., by C. W. STOUT, FURMAN D. HOLME, and others.—The Lake Spring Land & Improvement Co. has been incorporated at Pulaski City, Va., to build water-works. President, G. V. LITCHFIELD.—A water company is to be organized at Florence, Ala.—The Cortez Water Supply Co. has been incorporated at Denver, Col.; it will operate in La Plata county. Capital stock, $100,000.—The Morgan Water-Works & Ice Co. has been organized at Morgan, Tex.

New Water-Works and Extensions.—Camden, Me. The works will be completed early in July.—Waldo, Me. Work has been commenced on the foundation for the stand-pipe; the dam will soon be commenced.—Richmond, Me. The water-works are completed.—Cumberland, Me. The Yarmouth Water Co. will furnish a supply from the Mason spring.—Springfield, Mass. The fire service of Bay State village is being improved by 2000 ft. of 6-in. mains and several additional hydrants.—Turners Falls, Mass. Work is progressing on the pipe laying.—Cohoes, N. Y. The new 16-in. pumping main for reservoir No. 3 will be laid by day labor under the supervision of Superintendent KNIFFIN; it will be 6,500 ft. long and will cost $12,000.—Waterville, N. Y. A water supply is contemplated.—Pulaski, N. Y. A preliminary test of the works has been made.—Allegheny, Pa. The Superintendent has been directed to prepare plans and advertise for proposals for two large tanks. The Hyatt filter system is to be adopted.—Tuscaloosa, Ala. Water-works will be built by the Tuscaloosa Coal, Iron & Land Co.—South Pittsburg, Tenn. The reservoir is being enlarged and 5,000 ft. of new mains laid; C. CONNOR is Secretary of the South Pittsburg City Co.—Jerseyville, Ill. Plans and specifications are being prepared by G. C. MORGAN, of Chicago.—Benton Harbor, Mich. The village has been authorized to raise money for a water supply.—Black River Falls, Wis. The works have been completed. The engineers were LOWETH & CURTIS, St. Paul, Minn.—Marshall, Tex. Surveys are being made and the work will soon be advertised.—Bellevue, I. T. Work has been commenced.—Orangeburg, S. C. Address G. H. CORNELSON.—Wahoo Neb.—Crete, Neb.—Holdrege, Neb.—Manitou, Col.—Halstead, Kan.—Santa Ana, Cal.

WE will be obliged if every water-works superintendent or engineer, or other official in charge of the distribution of their official printed reports, will see that this office is furnished with a copy of each report issued since 1884, and also give us rates at which water is sold by them. We will be careful to acknowledge receipt of such reports and wherever there are any novel features of importance to the general public, we will be sure to note them in the columns of this journal. Early information also about elections of officers; about extensions of works; the purchase of new machinery and other news of direct interest to parties engaged in the construction and management of water-works is specially solicited. Be careful to address all correspondence to Tribune Building, New York City.

Proposals Open.

Railroad.—Grading and rock work on about 3½ miles of track near Lyons, Col. L. M. FOUTS, Superintendent, Denver, Utah & Pacific R. R., Denver, Col.

Canal.—Lake and canal at Melvin, Col. SMITH & HILL, Denver, Col.

Railroad.—Grading 50 miles of the Mobile & Birmingham Ry., in sections from 3 to 10 miles, to be subjet. J. H. MCLANE, Contractor, Mobile, Ala.

Paving.—Granite block paving; also crushed stone. GRENVILLE M. INGALSBE, Village Clerk, Sandy Hill, N. Y. June 20.

Railroad.—Grading for second track, from Alliance to Strasburg, Pa., 4¾ miles, on the Eastern division, and from Crestline to Robinson, 6½ miles, on the Western division, Pittsburg, Fort Wayne & Chicago R. R. F. SLATAPER, Chief Engineer, Pennsylvania Co., Pittsburg, Pa. June 20.

Street Work.—Regulating, grading, flagging and curbing. JOHN NEWTON, Commissioner of Public Works, 31 Chambers street, New York City. June 23 and June 28.

Paving Blocks.—Granite paving blocks, 60,000, dimensions 8 to 12 ins. by 3½ to 4½ ins. by 7 to 8½ ins. W. E. SYMS, Chairman, Committee on Highways, Holyoke, Mass. June 24.

Canal Work.—At locks 31 to 35, 44 to 46, 53 to 56, 60 to 62, and 72, Erie canal. Excavation, bridge and lock masonry, lining, puddling, concrete, piles, timber and plank, iron work, etc. Plans, specifications, etc., at the office of the Superintendent of Public Works, Albany, and at the office of the Division Engineer at Syracuse and Rochester. JAMES SHANAHAN, Superintendent of Public Works, Albany, N. Y. June 28.

Dredging.—In the Virginia channel of the Potomac river, at Washington. Lieut.-Col. PETER C. HAINS, U. S. Engineer Office, Washington, D. C. June 30.

Beacon.—Iron beacon on the lighthouse site at North Point, Milwaukee, Wis. Major S. M. MANSFIELD, U. S. Lighthouse Engineer, Detroit, Mich. June 30.

Caisson.—Iron floating gate or caisson for the navy yard at Boston, Mass. Plans and specifications at the office of the engineer at the Navy Yard, at the Stewart Building, New York, and the Navy Department, Washington. D. B. HARMONY, Chief of Bureau of Yards and Docks, Navy Department, Washington, D. C. June 30.

Sewer.—Brick outlet sewer, with pile foundation, at the U. S. carp ponds, Washington. THOMAS B. FERGUSON, U. S. Commission of Fish and Fisheries, Washington, D. C. July 1.

Bridge.—Highway bridge, and substructure, over the west channel of the Detroit river to Belle Isle. Plans and specifications at the office of the Board of Public Works, W. H. LANGLEY, President, Board of Public Works, Detroit, Mich. July 2.

Railroad.—Work on the Cape Breton Railway, from the Strait of Canso to Grand Narrows. Plans and specifications at Ottawa, and at Port Hawkesbury, C. B. A. P. BRADLEY, Secretary, Department of Railways and Canals, Ottawa, Canada. July 6.

Street Work.—Grading, curbing, crosswalks, gutters, macadamizing, culverts, drains, retaining walls, etc. THOS. G. SMITH, President, Board of Public Affairs, Cincinnati O. July 6-7.

Bridge and Substructure.—Removing old bridge masonry and approaches and building new abutments and pier for new bridge over the Ohio canal at Groveport, O. Also for an iron draw or swing bridge over the canal. FRANK J. REINHARD, County Auditor, Columbus, O. July 7.

Street Work.—Grading, draining and Medina sandstone paving. WALTER P. RICE, City Engineer, Cleveland, O. July 7.

Iron Pier.—At Marine Park, South Boston. Plans and specifications at the office of the City Engineer. THE PARK COMMISSIONERS, 87 Milk street, Boston, Mass. July 8.

Contracting.

Materials for Breakwater.—The following proposals for materials for the breakwater at Buffalo, were opened June 9, by Capt. F. A. MAHAN, U. S. Engineer Office, Buffalo, N. Y.: Williams & McConnel, Buffalo; stone, $3.50, $7.50, $8.50 and $1.84 for 1st, 2nd, 3rd and 4th, classes; Hanover cement, $2.52 per bl.; total bid, $29,571. Wm. E. Carroll, Buffalo; sand, $1.05 per cu. yd.; total, $5,880. Howard Fleming, New York; Gibbs cement, $2.09 per bl.; total, $5,120.50.

Water Pipe.—The following proposals were opened June 11 at the office of the Water Board, Boston, Mass.: Camden Iron Works; 1,100 tons of 24-in., $25 per ton; 120 tons of 30-in., $34.50; 450 tons of 48-in., $34; 80 tons of specials, $74. McNeal Foundry & Machine Co.; pipe, $35.50, $35, $35; specials 3½ cts. and Ys 4¼ cts. per pound.

Artesian Well.—The following proposals for drilling an artesian well at the State Lunatic Asylum, Milledgeville, Ga., were opened June 7, by I. H. DE SAUSSURE: L. B. Andrews, Bradford, Pa., 1,500 ft., $15,000; Downie Bros., Philadelphia, Pa., 1,500 ft., $12,340; Ray, Hambly & Sweet, Fernandina, Fla., 1,500 ft., $13,170; J. F. Gray, Chicago, 1,500 ft., $10,900; C. F. Boyer, Hazleton, Pa., 1,500 ft., $9,350; John W. Craig, Baltimore, 1,500 ft., $9,000. Thos. Murphy, Bradford, Pa., 1,500 ft., $7,500; Philadelphia Steam Driller Co., 1,500 ft., $7,200; Cushing & Carter, Bradford, Pa., 1,000 ft., $10,000; C. L. Grant, Anniston, Ala., 1,000 ft., $8,800. The contract was awarded to the Philadelphia Steam Driller Co.

Sewers.—At Amsterdam, N. Y., the contracts have been awarded as follows, for labor only: District No. 2, Benj. Van Vranken, Schenectady; No. 3, Stanton & Doyle, Cohoes; No. 4, Brown & Buckley, Mohawk; Nos. 5 and 6, Sherman & McDonough, West Troy. For material: James J. Dwyer, Utica. Cost for 15 miles, about $200,000. WM. B. LANDRETH is Chief Engineer. JOHN L. FITZ GERALD, of Landreth & Fitz Gerald, is Engineer in charge for the work at Green Island, N. Y., and will soon advertise for bids on 5 miles of sewers for that place.

City Contracts.—The following contracts were awarded June 9 by the Commissioner of Public Works, New York City: Sewers: in 75th street, C. O'Grady, sewer, $4 per ft.; rock excavation, $4 per cu. yd.; total, $10,824. In 138th street; Boitano & Reilly, sewer, $3; rock excavation, $4; timber, $27; total, $6,112. In 11th avenue; John Slattery, $4.96, $4.50, $25, $5,999.—Regulating and trap block paving: On 95th street, Thos. Gearty, $2.39 per sq. yd., $4,334.67. On 97th street, Thos. Gearty, $2.35; $8,497. On 135th street, P. H. McCullagh, pavement, $2.27 per sq. yd., curb, 60 cts. per ft., total $12,846.56.—Regulating and granite block paving: On 107th street, P. H. McCullagh, $2.52, per sq. yd., $3,582.40. On 129th street, P. H. McCullagh, pavement, $2.55 per sq. yd., curb, 75 cts. per ft., total, $3,392.40.

The following contracts were awarded June 14: Sewer in 116th street: Dennis McGrath, sewer, $5 per ft.; rock excavation, $3.96 per cu. yd.; timber, $25.80 per 1,000 ft. B. M.; 6-in. iron connections, 50 cts.; total, $12,312.60. Regulating and trap block paving: 64th street, $2.41 per

sq. yd.; total, $9,135.67; 74th street, the only bid from Wm. Kelly, $3.15, $8,851.50; 91st street, Thos. Gearty $2.37, $5,057.39; Chas. Guidet, $2.39, $20,918.24; 104th street, Leonard W. Johnson, $2.33, $9,005.82; 122nd street, $2.27; bridge stone, 60 cts. per sq. ft.; $5,831.78; 127th street, R. H. Fitzgerald, $2.33, $2,615.50. Regulating and granite block paving: 85th street, P. H. McCullagh, $2.61, $5,915.63; 118th street, Wm. Kelly, $2.47, bridge stone, 50 cts. per sq. ft., $6,932.12; 137th street, John B. Devlin, $2.65, 55 cts., $4,805.55.

Canadian Pacific Ry.—The contracts are let for the construction of the line from Holeb Pond, Somerset county, Me., to Mattawamkeag, on the Maine Central R. R., 120 miles. The work was let in ten contracts, as follows, commencing at Holeb Pond: Nos. 1 and 2, Luke Madigan; No. 3, 18 miles, Starrs, Askwith & Co.; Nos. 4, 5, 6, 7, about 53 miles, reaching to near Greenville, McKenzie, Mann & Co.; Nos. 8 and 9, Angus Sinclair, with headquarters at Lincoln; No. 10, James A. Gordon & Son. Several sub-contracts have been let. Tracklaying will begin by September and trains be running by November, on the greater portion of the line. A. L. HOOG, Montreal, is Chief Engineer; and JAS. ROSS, of Montreal, is Manager of Construction.

Railroad Contracts.—Cushing, Mallory & Co., of Lincoln, Neb., have contracts on the Wahoo and Schuyler extension, and 300 miles of the extension from Central City to Ord and the Loup valley, both for the Burlington & Missouri River R. R.

F. M. Ferguson & Co. have been awarded the contract for grading, bridging, ties and tracklaying on the Danville & Lagrange R. R., in Tennessee; they have now 500 men and 200 teams at work.

I. D. Hardin, of Chesterfield, N. C., has the contract for the construction of the Manchester & Augusta R. R., from Sumter, S. C., to the Santee river. F. GARDNER is Chief Engineer.

Munday, Carpenter & Grant (address W. E. H. SEARCY, Griffin, Ga.,) have the contract for the first 157 miles of the Birmingham & Atlantic Air Line Ry. Work is to be completed by February next.

Britton & Lyon, of Sherman, Tex., have the contract for 100 miles of the extension of the St. Louis, Arkansas & Texas R. R. from Commerce to Fort Worth.

James A. Gordon & Son, of Sherbrooke, Quebec, have the contract for 10 miles of the Canadian Pacific line west of Mattawamkeag, Me.; including the Penobscot river bridge. This firm built the European & North American Ry. from Passadumkeag to Vanceboro Me.

G. M. Garey, Cheneyville, La., has the contract for raising 32 miles of track on the Texas & Pacific R. R. between Bunkis and Alexandria; also for filling up trestles on the Rio Grande division.

Frank Hitch will build the railroad from Hamilton, N. C., to Tarboro.

The Virginia Construction Co., Richmond, Va., (President, J. B. PACE) has the contract to build the Tennessee Midland R. R. from Memphis into Virginia.

Louis McLain has the contract for the extension of the Southern Florida R. R. from Tampa to Black's Point.

M. D. Griffin, of Cheyenne, Wyo., has a grading contract on the Denver, Texas & Gulf R. R. from Pueblo, Col.

A. E. Beal, Thomas Fortune and Nathaniel Skelton, of Bismarck, Dak., have contracts for grading 57 miles of the Aberdeen, Bismarck & Northwestern R. R.

Grigsby Bros., Jefferson, Tex., have the contract for grading the Sabine, Galveston & St. Louis R. R. to Carthage, 16 miles.

H. C. Ballard & Co., M. Laurie, Sneath & Crook, Wells & Maguire, Franklin & Carroll, George Rankin, and Dittmer & Co., have contracts on the Glenwood Springs extension of the Denver & Rio Grande R. R.

The Roanoke Construction Co., Roanoke, Va., has the contract to build the Craig R. R.

Bays & Jeffery have commenced work on their contract for grading the narrow gauge Portland & Willamette Ry. from Elk Rock to Portland, Ore.

T. L. Houser, Lincolnton, N. C., has a contract for a railroad in Alabama; and Wright & Co., Charlotte, N. C., have a contract for a railroad in Georgia.

Wm. T. Harris & Co. have the contract for the Union Passenger Ry. at Richmond, Va.

E. W. Springall, of Dallas, Tex., has the contract for grading and bridging the Denison, Bonham & New Orleans Ry. from Denison, Tex., to Bonham, 28 miles. Work to be finished by October.

C. F. Cody and A. T. French have the contract for 4 miles of line from the Northern Pacific R. R. to the mines and ovens of the Livingston Coal & Coke Co., near Livingston, Mont.

Shephard & Co., of Minneapolis, have the contract for grading the St. Paul, Minneapolis & Manitoba R. R. to Bismarck, Dak. The contract has been sub-let to S. Lambert, of Bismarck.

Boilers and Engines.—The Southern Cotton Oil Co., Charlotte, N. C., has awarded contracts for boilers to the Abendroth & Root Manufacturing Co., and for engines to the Westinghouse Machine Co. The latter contract comprises 8 150-H.P., 2 75-H.P., 12 60-H. P., 22 45-H.P., 8 25-H. P. and 8 15-H. P. engines, aggregating 3,380-H. P.; it is probably the largest and most important single order for engines which has been given in this country. These engines are to go in eight different mills throughout the Southern States. Shafting is to be largely dispensed with, and the mill operated by independent power in each department. The Westinghouse engine has had a large trade amongst the cotton oil mills in the South, and the great economy of operation which has been obtained by the use of divided power has resulted in the placing of the entire order as above stated.

Dredging.—The following proposals for work in the Saco river, Maine, were opened June 11 by Major JARED A. SMITH, Portland, Me.: Dredging; Robert Hamilton, Chebeague, Me., 23 cts. per cu. yd. in scow; Moore & Wright, Portland, Me., 24 cts.; Thos. Symonds, Leominster, Mass., 34 cts. Contract awarded to Robert Hamilton. . emoving ledge; Thos. Symonds, Leominster, Mass., $10.25 per cu. yd. in situ; John F. Hamilton, Chebeague, Me., $18; Solon S. Andrews, Biddeford, Me., $18; Louis E. Lunt & Gardner Floyd, Portland, Me., $21.15. Contract awarded to Thomas Symonds.

The following proposals for work in the Rappahannock river, Virginia, were opened June 11 by S. T. ABERT, U. S. Engineer Office, Washington, D. C.: American Dredging Co., Philadelphia, Pa.; dredging, 23 cts. per cu. yd.; rock excavation, $7 per ton. John L. Johnson, Fulton, N. Y.; 30 cts., $7.

The following proposals for dredging in the Hudson river were opened June 13 by JAS. SHANAHAN, Superintendent of Public Works, Albany, N. Y. At Mull's light, 20,000 cu. yds.; P. W. Myers, Albany, 16¾ cts. per cu. yd.; Chas. Brown, Mohawk, 19¼ cts.; W. Johnson, Fulton, 20 cts.; E. M. Payn, Albany, 23½ cts.—At New Baltimore light, 8,000 cu. yds.; Chas. Brown, 19¾ cts.; W. Johnson, 22 cts.; E. M. Payn, Albany, 23½ cts.; P. W. Myers, Albany, 23¾ cts.

Railroads.

Birmingham & Atlantic Air Line R. R.—Of Southern railway projects, this, while one of the largest, is sufficiently well matured, and has a backing of such a character that its ultimate success seems to be well assured. The line of the road as surveyed runs from Birmingham, Ala., to La Grange, Ga. *via* Roanoke, Louina, Ashland and Talladega. From La Grange two lines run to the coast. One *via* Monticello, Sparta, Gibson and Augusta to Port Royal, S. C.; the other *via* Thomaston, Macon and Dublin to Savannah. In Georgia the line is located through a country where work and grades will be very light. In Alabama there is some difficult work, including two tunnels, one of 1,000 ft. and one 400 ft., also three large bridges. In Georgia there will be some large bridges but no tunnels. Right of way is all secured, and liberal subscriptions have been received from towns along the proposed line. As noted elsewhere 157 miles are under contract and the remainder will be let soon. The officers of the company are, DOUGLAS GREEN, of New York, President; M. F. TUTWILLER, Griffin, Ga., Chief Engineer; JOHN A. A. WEST, Roanoke, Ala., General Manager.

Grading and Tracklaying.—*East of Chicago.*—Cincinnati & Southern Ohio Ry. Grading is finished on this line from Lawrenceburg to Rising Sun, Ind., and tracklaying is in progress. The line is in the interest of the "Big Four" company.—Toledo, St. Louis & Kansas City Ry. The workmen engaged in laying track on a branch of this line in the city of Toledo, recently, had their labors interfered with by a mob of the property owners.

Southern.—South Florida R. R. Work is in progress on the extension from Tampa.—Maysville & Big Sandy R. R. Tracklaying is in progress at Riverton, Ky. The Phœnix Bridge Company is erecting the bridge over the Little Sandy river, in Greenup Co.

The Northwest.—St. Paul, Minneapolis & Manitoba Ry. It is stated that the contract has been let for a line from Minot, Dak., southeast to Coal Harbor, McLean Co. From this point the line will doubtless be extended to Bismarck; and if, as seems probable, the Aberdeen, Bismarck & Northwestern is really in this company's interest, this will give the Manitoba a direct line from Aberdeen to Minot. Grading is far advanced on the line from Wahpeton to Fargo, and it is reported that work has begun on a line from a point in Sargent county on the recently completed line from Rutland to Ellendale, northwest to Jamestown.—Forest City & Watertown R. R. Construction is to begin at once on this line near Bowdle, Dak.

The Southwest.—Denison, Bonham & New Orleans Ry. Grading is in progress between Denison and Bonham, and this part of the line, 28 miles in length, is to be completed by Oct. 1. FRED P. JAMES, of Denison, is Chief Engineer, and S. B. ALLEN, of Bonham, is President.—Missouri Pacific Ry. Grading is progressing on the Dallas & Hillsboro branch of the Missouri, Kansas & Texas Ry. The line, from Greenville to Jefferson, 123 miles, is to be changed to standard gauge this year.—Natchitoches R. R. This line, which is to be built, to Natchitoches, La., from a point on the Texas & Pacific Ry., 16 miles distant, will be completed at an early date, tracklaying having already begun.—Central Missouri R. R. The latest conjecture in regard to this line is that it is backed by the Illinois Central and will form that company's line to Kansas City.

Rocky Mountain and Pacific.—Denver & Rio Grande R. R. Work is nearly completed on the extension of the El Moro branch to Trinidad, Col. The line to Aspen and Glenwood Springs is being pushed, and it is thought that trains will reach Aspen as soon as those over the Colorado Midland. The grading on the extension to Montrose has just commenced.—Spokane & Palouse Ry. Grading on this line is nearly finished to Garfield, W. T., and tracklaying is to begin soon.—Northern Pacific Ry. The account of the ceremonies attending the driving of the last spike on the Cascade division, is quite impressive. At 6 P. M., on June 1, the last rail was in place and all the spikes were driven save the last one. Mrs. H. S. HUSON, wife of the assistant chief engineer, stepped to the front and, breaking a bottle of champagne over the last spike, drove it partly home. Several others assisted, and finally Assistant General Manager BUCKLEY struck the final blow at 6.02 P. M. The wires were connected directly with St. Paul, and at each blow on the spike the operator struck the key of his instrument so that the officials at St. Paul listened to the succession of clicks which answered to the blows of the sledge a half continent's width away. On the Cascade tunnel work is making good progress, each heading being advanced about 2,400 ft. The recent landslide at the Mullen tunnel in Montana, for the time, completely blocked the line. A large force was put at work at once relaying the old track over the mountain, which was abandoned with the completion of the tunnel, and the four miles of track were put down in short order leaving the company free to repair the caved-in tunnel at leisure, without interruption to traffic.

Surveys.—*East of Chicago.*—Boston & Quebec Air Line Ry. The location of this Maine road is progressing, and will be passed upon by the State railroad commissioners on June 28.—Rome & Carthage Ry. The preliminary survey of this line in northern New York shows the proposed route to be very favorable for easy construction.—Cincinnati, Hamilton & Dayton R. R. The preliminary survey for the extension from Richmond, Ind., to Jonesboro, is in progress under direction of E. A. PECK.

Southern.—Louisville & Nashville R. R. Five different parties are reported at work on the preliminary surveys for the Pineville extension.

The Northwest.—St. Louis, Alton & Springfield R. R. Co. This is the new title of the St. Louis & Central Illinois Ry., one of the old Wabash lines, running from Springfield to Grafton, Ill. The line is to be extended from Elsah to Alton, 12 miles, and a party are now at work on the location. The Calhoun & Northern R. R. is the name of the line proposed in this company's interest to run north from Grafton; and it will be placed under survey the last of the present month. H. A. FISHER, St. Louis, Mo., is General Manager.—Milwaukee, Lake Shore & Western Ry. It is reported that this company has made all arrangements to build a line to the Mississippi river, the extension running from Wausau *via* Marshfield and Black River Falls to La Crosse, Wis., about 160 miles. Several surveying parties are already in the field.—St. Paul, Minneapolis & Manitoba Ry. On the Brainerd & Northwestern line, which is to run from Milaca, Minn., *via* Brainerd to Leech Lake, several surveying parties are running preliminary lines. From Leech Lake the line will doubtless be extended to Crookston; which will give the company a line 275 miles in length through a region of Minnesota now far removed from railroad facilities. A survey is also in progress in southwestern Dakota for a line from Aberdeen *via* Faulkton to Pierre on the Missouri.

The Southwest.—Memphis, Arkansas & Texas Ry. The preliminary survey of this line, which is to run from Memphis, Tenn., to Marianna, Ark., has just begun. THOS. G. DABNEY, of Memphis, is Chief Engineer.—Union Pacific Ry. It is reported that the McPherson, Texas & Gulf R. R., for which a charter was recently filed, is to be no paper road but an actual extension on which construction will be pushed at once, the preliminary survey being already under way.

Rocky Mountain and Pacific.—Oregon Ry. & Navigation Co. The line from Pomeroy to Lewiston is still under survey, the route being through a very difficult country.

New Companies and Projects.—*East of Chicago.*—Iberville, Dunham & Clarenceville Ry. Co. At the recent stockholders' meeting the following officers were elected: President, E. J. CHAMBERLAIN, General Manager Canada Atlantic Ry.; Vice President, GEO. A. AYER, Manager Vermont Construction Co.; Treasurer, F. S. STRANAHAN, Treasurer National Dispatch Car Co. The proposed line of the road runs *via* Clarenceville,

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